Hydraulic Research
in the United States

1958

United States Department of Commerce

National Bureau of Standards

Miscellaneous Publication 224

The National Bureau of Standards

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1958

(Including Contributions from Canadian Laboratories)

Edited by Helen K. Middleton

FOREWORD

The information contained in this publication was compiled from reports by
the various hydraulic and hydrologic laboratories in the United States and
Canada. The cooperation of these agencies is greatly appreciated. The National
Bureau of Standards cannot assume responsibility for the completeness for this
publication. We must depend upon reporting laboratories for the completeness
of the coverage of their own programs, as well as upon new laboratories engaged
in hydraulics to bring their activities to our attention.

Projects are numbered chronologically, and the number once assigned is
repeated for identification purposes until a project is completed. Numbers
commencing with 2741 refer to projects which are reported for the first time.
All projects are in active state, unless otherwise noted under (f).

The National Bureau of Standards does not maintain a file of reports or
detailed information regarding the research projects reported by other organi-
zations. Such information may be obtained from the correspondent listed under
(c) or immediately following the title of the organization reporting the work.
It is of course understood that any laboratory submitting reports on its work
will be willing to supply information to properly qualified inquirers.

A similar bulletin, "Hydraulic Research", compiled and published by the
International Association for Hydraulic Research, contains information on
hydraulic research being conducted in foreign countries. This bulletin is
edited by Professor J. Th. Thijsse, Director of the Hydraulic Laboratory at the
Technical University of Delft, Netherlands, and Secretary of the International
Association for Hydraulic Research. Copies may be obtained from the Secretary
at $6.00 each (postage included).

A. V. Astin, Director

CONTENTS

Key to Projects

    (a) Number and title of project   (e) Description
    (b) Project conducted for   (f) Present status
    (c) Correspondent   (g) Results
    (d) Nature of project   (h) Publications

UNIVERSITY OF ARKANSAS 1
Agricultural Engineering Dept.
Fayetteville, Ark.
Prof. Kyle Engler, Head

UNIVERSITY OF ARKANSAS 1
Civil Engineering Dept.
Fayetteville, Ark.
Prof. L. R. Heiple, Head

BALDWIN-LIMA-HAMILTON CORPORATION, THE 1
Hydraulic Turbine Laboratory
Philadelphia 42, Pa.
Mr. A. W. Madora, Supervisor, Hydraulic Turbine
Engineering Dept.

BALDWIN-LIMA-HAMILTON CORPORATION, THE 2
Pelton Division, 2929-19th Street
San Francisco 10, Calif.
Mr. R. M. Bacchi, Development Engineer

BEACH EROSION BOARD (see U. S. Government)

BONNEVILLE HYDRAULIC LABORATORY (see U. S. Government)

BROOKLYN, POLYTECHNIC INSTITUTE OF 2
99 Livingston Street, Brooklyn 2, N. Y.
Prof. Matthew W. Stewart, Civil Engineering

CALIFORNIA INSTITUTE OF TECHNOLOGY 2
Civil Engineering Department
Pasadena 4, Calif.

CALIFORNIA INSTITUTE OF TECHNOLOGY 2
Engineering Division, Pasadena 4, Calif.
Prof. Milton S. Plesset, Applied Mechanics

CALIFORNIA INSTITUTE OF TECHNOLOGY 3
Hydrodynamics Laboratory
Pasadena 4, Calif.

CALIFORNIA INSTITUTE OF TECHNOLOGY 3
Sedimentation Laboratory, Pasadena 4, Calif.
Dr. Vito A. Vanoni, Professor of Hydraulics

CALIFORNIA, UNIVERSITY OF 4
College of Agriculture, Davis, Calif.
Mr. Robert M. Hagan, Chairman, Dept. of Irrigation

CALIFORNIA, UNIVERSITY OF 6
College of Agriculture, Los Angeles 24, Calif.
Prof. A. F. Pillsbury, Chairman
Dept. of Irrigation and Soils

CALIFORNIA, UNIVERSITY OF 7
College of Engineering, Berkeley 4, Calif.
Dr. H. A. Einstein, Prof. of Hydraulic Engineering

CALIFORNIA, UNIVERSITY OF SOUTHERN 12
Dept. of General Engineering
Los Angeles 7, Calif.
Dr. K. C. Reynolds, Head

CALIFORNIA, UNIVERSITY OF SOUTHERN 12
Research Foundation for Cross-Connection Control
Los Angeles 7, Calif.
Dr. K. C. Reynolds, Supervisor

CARNEGIE INSTITUTE OF TECHNOLOGY 13
Dept. of Civil Engineering, Pittsburgh 13, Pa.
Dr. T. E. Stetson, Acting Head

COLORADO SCHOOL OF MINES 13
Civil Engineering Dept., Golden, Colo.
Prof. Henry A. Babcock

COLORADO STATE UNIVERSITY 13
Civil Engineering Section, Fort Collins, Colo.
Dr. A. R. Chamberlain, Chief

COLUMBIA UNIVERSITY 20
Dept. of Civil Engineering and Engineering
Mechanics, New York 27, N. Y.
Dr. Richard Skalak, Director
Fluid Mechanics Laboratory

CONNECTICUT, UNIVERSITY OF 21
Civil Engineering Dept., Box U-37, Storrs, Conn.
Prof. Victor Scottron, Prof., Civil Engineering

CORNELL UNIVERSITY 21
Dept. of Agricultural Engineering, Ithaca, N. Y.
Prof. O. C. French, Head of Department

CORNELL UNIVERSITY 21
School of Civil Engineering, Ithaca, N. Y.
Dr. N. A. Christiansen, Director
Dr. Andre L. Jorissen, Head, Dept. of Hydraulics
and Hydraulic Engineering

DAVID TAYLOR MODEL BASIN (see U. S. Government)

FLORIDA, UNIVERSITY OF 22
Coastal Engineering Laboratory of the Dept. of
Engineering Mechanics, Gainesville, Fla.
Dr. Per Brunn

GEORGIA INSTITUTE OF TECHNOLOGY 24
Hydraulic Laboratory, School of Civil Engrg.
Atlanta, Ga.
Prof. C. E. Kindsvater

HOUSTON UNIVERSITY 25
Dept. of Chemical Engineering, Houston 4, Texas
Prof. J. R. Crump, Chairman

IDAHO, UNIVERSITY OF 25
Engineering Experiment Station, Moscow, Idaho
Dean Allen S. Janssen, Director

ILLINOIS STATE WATER SURVEY DIVISION 26
Box 232, Urbana, Ill.
Mr. William C. Ackerman, Chief

ILLINOIS STATE WATERWAYS DIVISION 30
Dept. of Public Works and Buildings
201 West Monroe St., Springfield, Ill.
Mr. Thomas B. Casey, Chief Waterway Engineer

ILLINOIS, UNIVERSITY OF 30
Dept. of Agriculture Engineering, Urbana, Ill.
Dr. Frank B. Lanham, Head

ILLINOIS, UNIVERSITY OF 30
Dept. of Civil Engineering, Urbana, Ill.
Prof. J. J. Doland, Dir., Hydraulic Engineering

UNIVERSITY OF ARKANSAS, Agricultural Experiment Station.

(2255) GROUND WATER, RESOURCES AND RECHARGE, IN THE RICE GROWING AREA OF ARKANSAS.

(b) Arkansas Agricultural Experiment Station, University of Arkansas.
(c) Prof. Kyle Engler, Head of Agricultural Engineering Dept., University of Arkansas, Fayetteville, Arkansas.
(d) Basic and applied research.
(e) A 16-inch vertical recharge well is surrounded by test wells for the purpose of observing hydraulic information and for sampling chemical quality and bacterial analyses. A series of tests of short duration have been run using treated surface water as recharge media. This water has been copper sulphated to kill plankton, treated with alum to clock out collodial materials, chlorinated to kill bacteria, and aerated to remove free air. This treated water has given satisfactory results in the tests. The next step will be removal of treatments to see what the minimum treatment will have to be.
(g) The project is not developed to a point for satisfactory reporting.
(h) "Ground Water Recharge by Means of Wells", by G. W. Steinbruegee, L. R. Heiple, N. Rogers, and R. T. Sniegocki. Mimeographed report, Agricultural Experiment Station, University of Arkansas, September 1954.

UNIVERSITY OF ARKANSAS, Civil Engineering Dept.

(2741) ROCKEFELLER FILTRATION PROJECT.

(b) Laboratory project.
(c) Prof. L. R. Heiple, Head, Civil Engineering Dept., University of Arkansas, Fayetteville, Arkansas.
(d) Experimental and field investigation; applied research and has been used for two master's thesis to date.
(e) This project involves a study of the removal of turbidity and bacteria from surface water supplies using coarse grained media (1/4" to 1"). Variables investigated included: (1) Depth of bed; (2) size of media; (3) shape and nature of media; (4) effect of head of water on filter bed; and (5) rate of filtration. Laboratory model investigations are complete with long range field study under way for the past four months. Significant field data should be available by September 1958.
(h) Master's Thesis by Nixon W. Powell and Bennie J. McCoy available at University of Arkansas Library.

THE BALDWIN-LIMA-HAMILTON CORPORATION, Hydraulic Turbine Laboratory.

Inquiries concerning Projects Nos. 271, 2050, 2500, 2742, and 2743 should be addressed to Mr. W. R. MacNamee, Chief Engineer, Hydraulic Turbine Dept. and Mr. A. W. Madora, Supervisor, Hydraulic Research Laboratory, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pennsylvania.

(271) ADJUSTABLE AND FIXED BLADE PROPELLER-TYPE HYDRAULIC TURBINE MODELS.

(b) Laboratory project.
(d) Experimental; applied research for design.
(e) To improve performance of present designs, and to extend the range of application of this type turbine. Propeller runners of various designs in combination with modified turbine settings are methodically tested in the 11-inch cavitation flume. Efficiency output, cavitation, runaway speed, hydraulic thrust, and hydraulic blade torque are measured.
(g) Results provide data for improvement of existing design and information for designs which extend the range of application.

(2050) PUMP TURBINE LABORATORY.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Pump-turbines of various specific speeds have been designed and tested in settings hydraulically similar to proposed field installations. The performance characteristics of efficiency, discharge, runaway speeds, horsepower, cavitation, thrust data for thrust bearing, and wicket gate torques.
(g) Results provide data for the design of future proposed installations and modifications to existing designs.

(2500) AXIAL FLOW PUMP LABORATORY.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Axial flow pumps of various specific speeds have been designed and tested. Investigations pertaining to the number of impeller blades, proper diffuser vane angle, and intake conditions, have been completed. Performance characteristics of efficiency, discharge, horsepower, runaway speeds and blade torques have been obtained.
(g) Results provide data for the design of future proposed installations, and modifications to existing designs.

(2742) ST. LAWRENCE POWER PROJECT, LEWISTON POWER PLANT.

(b) Power Authority of the State of New York.
(d) Official contract acceptance tests.

(e) A complete homologous model has been tested encompassing the entire operating conditions expected in the field.
(g) Results obtained generously exceed all guaranteed conditions as requested by customer in specifications.

(2743) CONTROLLABLE PITCH PROPELLER BEARING TEST.

(b) Bureau of Ships, Department of the Navy.
(d) Experimental; applied research.
(e) One quarter scale section of controllable pitch propeller hub section and simulated blade using hydraulic cylinders for centrifugal, thrust, and blade actuating forces. Comparisons of bearing friction, wear rate, life, compressibility, using different methods of blade attachments are studied. Hub section strain gaged for stress analysis of blade retaining flange.
(g) Bearing materials, having high lead content to resist high starting friction, are more suitable even with shorter life expectancy. Bearing material selection should be made using type of load application as a criterion.

THE BALDWIN-LIMA-HAMILTON CORPORATION, The Pelton Division.

(2744) MODEL TESTS OF TURBINES FOR OIL-WELL TURBO-DRILLING.

(b) Laboratory project.
(c) Mr. R. M. Bacchi, Pelton Division, Baldwin-Lima-Hamilton Corp., 2929 - 19th Street, San Francisco 10, California.
(d) Experimental; development.
(e) A two-stage full sized model is tested for its efficiency. At the same time various under water thrust and radial bearings are being tested.

POLYTECHNIC INSTITUTE OF BROOKLYN.

(2745) SOIL PERCOLATION STUDY.

(b) Laboratory project.
(c) Prof. Paul R. DeCicco, Dept. of Civil Engineering, Polytechnic Institute of Brooklyn, 99 Livingston St., Brooklyn 1, New York.
(d) Master's Thesis by Francis V. Padar.
(e) A study of the long time percolation rate through soils using a gas free percolant.
(f) Suspended.
(g) Satisfactory apparatus developed and initial tests run.
(h) Thesis available on loan.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Civil Engineering Department.

(2258) THE RESUSPENSION OF FLOCCULENT SOLIDS IN

SEDIMENTATION BASINS.

(b) The United States Public Health Service.
(c) Dr. A. C. Ingersoll, California Institute of Technology, Pasadena, California.
(d) Experimental, directed from theoretical considerations. Basic research. Fundamental study on mechanics of flocculent suspensions is doctoral thesis material for Mr. R. T. McLaughlin.
(e) The purpose of the project is (a) to investigate the resuspension of flocculent settled material from the sludge bed in settling tanks, (b) to minimize this resuspension, thereby improving the efficiency of settling tanks, (c) to test the methods evolved from theory in laboratory models and in full-scale settling tanks, and (d) to evaluate current parameters of efficiency for settling tanks and to provide laboratory apparatus that will yield better measures of performance.
(g) Studies in 1957 have been directed toward the study of discrete and flocculent solids in the sludge bed of a settling tank for values of the bed Reynolds number in the neighborhood of one and less. Both discrete and flocculent particles were shown to move at bed shear values less than those reported in the classic work of A. Shields (see Fig. 11 of "Sedimentation and the Design of Settling Tanks", by Thomas R. Camp, Trans. ASCE, Vol. III, (1946) p. 895). The glass-walled flume 14 ft long by 16 in. wide is now equipped with a model sludge-removal mechanism built on a scale of 1:12. The mechanism is of the endless chain-belt type with flight scrapers. The effect of the moving (or even stationary) flight scrapers is to make resuspension of bed materials easier than is the case with the smooth floor.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Engineering Division.

(1548) SPECIAL PROBLEMS IN HYDRODYNAMICS.

(b) Office of Naval Research, Dept. of the Navy.
(c) Prof. Milton S. Plesset, California Institute of Technology, Engineering Div., Pasadena, California.
(d) Theoretical and experimental; basic research.
(e) Studies of cavitating and noncavitating flow; dynamic behavior of cavitation bubbles; theoretical and experimental studies of cavitation damage.
(h) "Physical Effects in Cavitation and Boiling", by M. S. Plesset, Proc. of ONR Symposium on Naval Hydrodynamics, Sept. 1956 (in press).
"On the Theory of Surface Waves in Water Generated by Moving Disturbances", by C. R. De Prima and T. Y. Wu, California Institute of Technology, Engineering Div. Report No. 21-23, May 1957.

"The Hydrodynamics of Spherical Cavities in the Neighborhood of a Rigid Plane", by Joseph M. Green, California Institute of Technology, Engineering Division Report No. 85-1, July 1957.

"Fully Cavitating Hydrofoils in Nonsteady Motion", by Blaine R. Parkin, California Institute of Technology, Engineering Div. Report No. 85-2, July 1957.

"Water Waves Generated by the Translatory and Oscillatory Surface Disturbance:, by T. Yao-tsu Wu, Calif. Inst. of Tech., Engineering Div. Report No. 85-3, July 1957.

"Incipient Cavitation and Wake Flow Behind Sharp-Edged Disks", by R. W. Kermeen and B. R. Parkin, Calif. Inst. of Tech., Engineering Div. Report No. 85-4, Aug. 1957.

"A Simple Method for Calculating the Drag in the Linear Theory of Cavity Flows", by T. Yao-tsu Wu, Calif. Inst. of Tech., Engineering Div. Report No. 85-5, Aug. 1957.

"A Linearized Theory for Nonsteady Cavity Flows", by T. Yao-tsu Wu, Calif. Inst. of Tech., Engineering Div., Report No. 85-6, Sept. 1957.

"Ion Exchange Kinetics - A Nonlinear Diffusion Problem", by F. Helfferich and M. S. Plesset, Calif. Inst. of Tech., Engineering Div. Report No. 85-7, Sept. 1957. (This study was supported only in part by ONR.)

"The Growth of Vapor Bubbles in Rapidly Heated Liquids", by S. A. Zwick and M. S. Plesset, Calif. Inst. of Tech., Engineering Div. Report No. 85-8, (in preparation).

(1816) FORCE CHARACTERISTICS OF SUBMERGED HYDRO-FOILS UNDER CAVITATING CONDITIONS.

   (b) Bureau of Ships, Dept. of the Navy.
   (c) Prof. Milton S. Plesset, Calif. Inst. of Tech., Engineering Div., Pasadena, Calif.
   (d) Theoretical and experimental; basic research.
   (e) Studies of hydrofoils.
   (h) "Water Tunnel Techniques for Force Measurements on Cavitating Hydrofoils", by Blaine R. Parkin and Robert W. Kermeen, Calif. Inst. of Tech., Hydrodynamics Laboratory Report No. 47-10, Feb. 1957. Journal of Ship Research, Vol. 1, No. 1, pp. 36-42, April 1957.
        "Experimental and Theoretical Investigations of a Supercavitating Hydrofoil", by R. L. Waid and Z. M. Lindberg, Calif. Inst. of Tech., Engineering Div. Report No. 47-8, April 1957.

(2503) EXPERIMENTAL STUDY OF VORTEXING IN LIQUIDS DRAINING FROM A CYLINDRICAL TANK.

   (b) Convair, San Diego, California.
   (c) Prof. Milton S. Plesset, Calif. Inst. of Tech., Engineering Div., Pasadena, Calif.
   (d) Theoretical and experimental; basic research.
   (e) Study of viscous damping in rotational flows; flow discharge of rotating liquids in cylindrical tanks.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Hydrodynamics Laboratory.

(2502) MECHANICS OF CAVITATION DAMAGE.

   (b) National Science Foundation.
   (c) Dr. Vito A. Vanoni, Hydrodynamics Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
   (d) Experimental; laboratory and field.
   (e) The specific objectives of this program are to attempt to clarify the effects on the cavitation damage potential of two variables: the physical size of the guiding surface or body, and the flow velocity. In this phase the work will be restricted to the investigation of the fixed type cavitation.
   (g) Some experimental techniques have been developed to study the problem, and experiments are in progress.

(2746) HYDRODYNAMICS OF UNDERWATER BODIES.

   (b) Bureau of Ordnance, Department of the Navy.
   (c) Dr. Vito A. Vanoni, Hydrodynamics Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
   (d) Experimental and theoretical investigations.
   (e) Investigations of the mechanics of hydro-dynamic phenomena involved in the motion of underwater bodies, including (1) studies of forces on such bodies in cavitating and noncavitating conditions; (2) investigations of the detailed mechanics of the fluid motions giving rise to the above forces.
   (f) The program is in its initial stages.

CALIFORNIA INSTITUTE OF TECHNOLOGY, Sedimentation Laboratory.

(6) MECHANICS OF SEDIMENT TRANSPORTATION.

   (b) Supported by Laboratory and the U. S. Army, Corps of Engineers, Missouri River Div.
   (c) Profs. Vito A. Vanoni and N. H. Brooks, Sedimentation Lab., Calif. Inst. of Tech., Pasadena, Calif.
   (d) Experimental and theoretical; basic research.
   (e) To investigate the mechanics of transportation of sediment by flowing fluids, including studies of the suspended load as well as the bed load phases of the problem.
   (f) Project completed.
   (h) Closing discussion of paper by Norman H. Brooks entitled "Mechanics of Streams with Movable Beds of Fine Sand."
        "Laboratory Studies of the Roughness of Suspended Load of Alluvial Streams", by Vito A. Vanoni and Norman H. Brooks, Calif. Inst. of Tech., Sedimentation Laboratory Report No. E-68, December 1957.

(2747) STUDY OF THE DESIGN OF LOW DROPS AND THEIR EFFECT ON THE CAPACITY OF FLOOD CHANNELS.

(b) U. S. Dept. of Agriculture, Soil Conserva-
tion Service, Berkeley, Calif.

(c) Prof. Vito A. Vanoni, Sedimentation Labora-
tory, Calif. Inst. of Tech., Pasadena, Calif.

(d) Experimental investigation carried on by
graduate students.

(e) The work is carried out in a specially de-
signed tilted flume to obtain information
for use in connection with the design of
flood control channels.

(g) No results are available as yet since
project was initiated this summer.

(2748) STUDY OF RELATIONS BETWEEN THE TRANSPORT OF
SEDIMENT AND THE HYDRAULIC CHARACTERISTICS
OF STREAMS.

(b) U. S. Dept. of Agriculture, Agricultural
Research Service.

(c) Prof. Vito A. Vanoni, Calif. Inst. of Tech.,
1201 E. California St., Pasadena, Calif.

(d) Experimental and analytical basic research.

(e) This work, the experimental part of which
will be carried on in laboratory flumes, is
an extension of the program of sedimenta-
tion research which has been carried on by
the Sedimentation Laboratory for some time.
The program will include investigation of
the sedimentation phenomena that occur at
high Froude numbers with values in the
neighborhood of unity.

(g) No results are available since the project
has just been initiated.

UNIVERSITY OF CALIFORNIA, College of Agriculture,
Department of Irrigation.

(21) STUDY OF HYDRAULICS OF SPRINKLING SYSTEMS.

(b) California Agricultural Experiment Station.

(c) Prof. V. H. Scott and Prof. J. R. Davis
Dept. of Irrigation, University of Calif.,
Davis, California.

(d) Experimental; operation.

(e) Studies on distribution of water applied
by sprinklers and irrigation efficiency
were continued. To evaluate the importance
of sprinkler and lateral spacings on dis-
tribution under actual field conditions, 7
different combinations of sprinkler and
lateral spacings were tested. An extensive
study was conducted to evaluate the effec-
tiveness of sprinkler and surface irriga-
tion of cotton. The objectives of this
study included (1) cost of irrigation; (2)
yield of cotton; (3) cotton fiber charac-
teristics; (4) salt concentration; and (5)
the net and gross water application to the
crop.

(g) Improved water distribution can be obtained
under windy conditions by closer spacing
of sprinklers and laterals. Medium capac-
ity sprinklers at 30-foot spacing gave the
best distribution with a greater range and
choice of lateral spacing. Results of the
sprinkler versus surface irrigation studies
conducted on cotton indicated little or no
difference in seed cotton, seed weight,

lint percentage, color and strength of
cotton taken from the surface and sprinkler
irrigated plots. The operational costs for
the sprinkler system were slightly higher
than for the surface systems.

(h) "Sprinkler and Lateral Spacing", V. H. Scott
and J. A. Corry, California Agric. 11(4),
30-31, April 1957.

(23) HYDROLOGY OF IRRIGATION SUPPLIES IN CALIF.

(b) California Agricultural Experiment Station.

(c) Prof. R. H. Burgy, Dept. of Irrigation,
University of Calif., Davis, Calif.

(d) Experimental and field investigation;
applied research and operation.

(e) The studies on the hydrologic effects of
various watershed practices are being con-
tinued. Seven major study areas are now
in operation throughout the northern sec-
tions of California. Management programs
on brush-covered lands usually require a
minimum of 3-5 years to complete the cycle
of removal, revegetation and conversion.
Hydrologic studies of this type utilize
natural precipitation and consequent runoff
as the basis for determining responses to
treatments. An important factor in pre-
cipitation disposal on mountainous water-
sheds is that of interception losses under
different vegetative covers on typical
watershed land. To determine water yield
increases after conversion from brush to
grass requires a knowledge of the intercep-
tion losses in the grass cover as well as
the original brush cover. Problems asso-
ciated with water supply in upland regions,
storage or water in small ponds, and reser-
voirs are being investigated.

(g) Manipulation of vegetation, as a form of
management of brush covered watersheds,
has shown promise as a means of increasing
seasonal runoff. Programs of vegetation
management to convert brush to desirable
forage species are being actively pursued
particularly on those areas most adaptable
as livestock ranges. Such programs are of
dual benefit through improvement of ranges
and increased water yields. Long-term
studies of the hydrologic effects of brush-
grass conversions have shown increased
yields of runoff water except in the drier
climates. Upon completion of a cycle of
revegetation, which takes approximately
three seasons of growth to become stable,
erosion has been effectively reduced over
that which occurs normally under brush
cover.

(h) "Water Management", R. H. Burgy and A. F.
Pillsbury, California Agric. 11(4):5, 38,
April 1957.

(24) MEASUREMENT OF IRRIGATION WATER AND IM-
PROVEMENT IN FARM IRRIGATION STRUCTURES.

(b) California Agricultural Experiment Station.

(c) Prof. V. H. Scott and Prof. J. R. Davis,
Dept. of Irrigation, University of Calif.,
Davis, California.

(d) Experimental; design.

(e) Extensive field experiments were conducted on the use of polyethylene film of varying thickness for linings of farm ditches under a wide range of soils, crops and irrigation systems. Mechanical methods of laying light weight films to eliminate some of the installation labor are being studied, and a study of the economics of ditch liners has been started. Investigations were initiated to determine flow characteristics of an 8-inch siphon for free flow and submerged flow conditions through a head range of 2-12 inches. Venturi flumes were modified for use in making inflow and outflow measurements in furrows.

Theoretical studies on the flow of water in irrigated furrows have been initiated, and a laboratory analysis on flow in shallow channels as affected by roughness and slope is underway. Infiltration of water into soils from furrows is being studied in both models and in the field. Studies are underway to determine how ground-water recharge can best be accomplished.

Methods of measuring flow of water in sprinkler irrigation systems is being studied. Emphasis is on low cost and ease of construction and installation.

(g) Certain prefabricated materials used as linings in small irrigation ditches to control seepage and vegetation show considerable promise. Relatively high initial cost and questionable longevity limit their use. Increased production and availability of some of the plastics are lowering costs to a point where replacement may be economical. A 25-slide sequence of some of the ditch lining operations has been prepared. An improved type of trailer was designed for the purpose of hauling aluminum irrigation pipe.

(h) "Prefabricated Ditch Linings", V. H. Scott, California Agric. 11(4):28, April 1957.
"Irrigation Efficiency Study", Jewell L. Meyer, H. W. Ross, V. H. Scott, and C. E. Houston, California Agric. 11(4):26-27, April 1957.
"Surface Irrigation", J. C. Marr, Calif. Agric. 11(4):27, April 1957.
"Grading Land for Surface Irrigation", J. C. Marr, California Agric. Exp. Sta. Cir. 438, 1957 (revised).
"Recharge Studies", W. A. Hall, California Agric. 11(4):4, April 1957.
"Recharging Ground Water by Irrigation", W. A. Hall, R. M. Hagan, and J. D. Axtell, Agric. Engin. 38(2):98-100, Feb. 1957.

(25) PHYSICAL AND CHEMICAL FACTORS AFFECTING SOIL INFILTRATION RATES.

(b) California Agricultural Experiment Station.
(c) Prof. L. D. Doneen and Prof. D. W. Henderson, Univ. of Calif., Davis, Calif.
(d) Experimental and field; basic and applied research.
(e) Studies are continuing on soil and water management practices which are important in coping with the widespread problem of soil penetration by irrigation water. Soil management practices such as cover cropping, growing green manure crops, and crop rotation need more study. A research program aimed towards finding means of determining the suitability of irrigation waters for crop use includes studies on (1) the total salt concentration; (2) the amount of sodium and its relationship to other salts; and (3) individual constituents, or salt that might be harmful to plants. In addition, climatic conditions, soil type, drainage, irrigation management and type of plant grown are being studied.

(g) Slow water penetration is caused by several soil conditions: excessive sodium absorbed by the soil; high clay content; soil compaction by traffic or tillage; and unstable soils which run together on wetting. Highly compacted soils can be recognized by digging or probing, especially if the soil lying below the compact zone is otherwise similar. The deterioration in quality of water is due primarily to the increase in mineral constituents and the total salt concentration. Although there are many exceptions, in general the more salt a water contains the poorer its quality. In most of the irrigation waters total salt concentrations are not sufficiently high to be injurious to plant growth, but rather their accumulation in the soil produces salines. If the percent sodium is low, good friable soil structure is maintained and the soil will take water readily. However, if the sodium percentage is high, the soil will disperse, the structure is destroyed, and the rate of water infiltration is reduced.

(h) "Quality of Irrigation Waters", L. D. Doneen and D. W. Henderson, California Agric. 11(4): 7, 8, 12, 31, 37, April 1957.
"Reclaimed Water", H. A. Schreiber, California Agric. 11(4): 8, April 1957.
"Water Penetration of Soils:, D. W. Henderson and J A. Vomocil, California Agric. 11(4): 23, 29, 37, April 1957.
"Production of Sugar Beets Following Winter Green Manure Cropping in California: II. Soil Physical Conditions and Associated Crop Response", W. A. Williams, L. D. Doneen and David Ririe, Soil Sci. Soc. Amer. Proc. 21(1): 88-94, Jan.-Feb. 1957.

(1819) DRAINAGE IN RELATION TO IRRIGATION.

(b) California Agricultural Experiment Station.
(c) Prof. J. N. Luthin, Dept. of Irrigation, University of California, Davis, Calif.
(d) Experimental and field investigation; basic and applied research.
(e) Since there are many areas along the major rivers in California where seepage is causing damage to adjacent agricultural land, a study was made of the possibility of using drainage wells. Piezometers, installed at many points in the field, enabled the determination of the subsurface water flow and the location of the various

strata below the ground surface. Drainage and alkali reclamation problems were studied in several areas of the state. A survey was conducted to define present drainage problem areas and to predict areas where these problems might develop due to importation of large quantities of surface water into the San Joaquin Valley for irrigation purposes.

(g) Operation of the pumped well was found to be quite effective in reducing pressure in the artesian aquifer. Recovery of water levels in deep piezometers permitted a determination of the average transmissibility coefficient of the aquifer based on the Theis nonequilibrium equation. The Theim method was also used but without as consistent results as those given by the Theis method. Because the test drainage well was feasible but not economical, a subsurface drainage system was designed and installed. This system will need further study to judge its effectiveness. Water table level data as well as other pertinent information for the areas in the counties of the San Joaquin Valley where drainage has been a problem during the period 1946-1957 have been summarized.

(h) "Drainage and Alkali Reclamation in Lassen County", P. W. Lamborn, J. N. Luthin, Univ. of California Agricultural Extension Service, 7 pages, 1957.
"Drainage Adjacent to a River", J. N. Luthin and V. H. Scott, California Agric. 11(4): 34, 36, April 1957.
"Drainage Cost Survey", P. A. Boving, California Agric. 11(4): 33, April 1957.

(2055) THE PHYSICS OF SOIL MOISTURE MOVEMENT.

(b) California Agricultural Experiment Station.
(c) Prof. J. N. Luthin, Dept. of Irrigation, University of California, Davis, Calif.
(d) Laboratory and theoretical studies; basic research.
(e) The rate of drop of the water table governs the length of time that plants will be exposed to water-logging conditions and hence is an important factor in the design of tile drainage systems. Studies were made of the falling water table in tile drainage. A tank was filled with sand and tile were placed in the tank to simulate a tile spacing of 20 feet with the tile placed 4 feet below the soil surface and 2 feet above an impermeable layer. The data collected from the experiment were used to develop some empirical relationships between the flow into a tile line and the height of the water table at the mid-point between the lines.
(g) Electrical analogs made out of Teledeltos paper with electrodes of Dupont silver paint were used to develop criteria for the depth and spacing of tile drains in soil overlying an artesian aquifer.
(h) "The Falling Water Table in Tile Drainage--a Laboratory Study", J. N. Luthin and R. V. Worstell, Soil Sci. Soc. Amer. Proc., Vol. 21, 1957.

(2056) THE HYDRAULIC CHARACTERISTICS OF WELL CASING PERFORATIONS.

(b) California Agricultural Experiment Station.
(c) Prof. V. H. Scott, Dept. of Irrigation, University of California, Davis, Calif.
(d) Experimental; applied research.
(e) Studies on the analysis of flow through well casing perforations were continued to a limited extent. Information was obtained on the behavior of two additional types of commercial casings--both of which had horizontal perforated openings.
(f) Temporarily suspended.
(g) Head loss coefficients have been determined for a selected number of punched and two types of chiselled perforations. Significant differences in the effect of the size distribution and shape of the gravel surrounding the perforations have been detected.
(h) "Hydraulic Properties of Perforated Well Casings", Y. Vaadia and V. H. Scott, Amer. Soc. Civ. Engin. Proc., 1957.

UNIVERSITY OF CALIFORNIA, Division of Agricultural Sciences, Dept. of Irrigation and Soils.

(26) DRAINAGE INVESTIGATIONS IN COACHELLA VALLEY, CALIFORNIA.

(b) Cooperative between the Coachella Valley County Water District, Coachella, Calif.; U. S. Salinity Laboratory, Riverside, Calif.; U. S. Bureau of Reclamation, Boulder City, Nevada; and this laboratory.
(c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soils, Univ. of Calif., Los Angeles 24, Calif.
(d) Field investigations; applied research and design.
(e) To develop and improve techniques for observing shallow ground water movement, for reclamation of saline and alkali soils and alkali soils, and for installation of drainage devices and systems.
(f) This project which has been active for about a dozen years is now becoming inactive.
(g) Techniques for land reclamation and design criteria for drainage systems were developed.

(27) HYDROLOGY OF WATER SUPPLIES IN CALIFORNIA.

(b) Laboratory project coordinated with the Dept. of Irrigation, Univ. of California, Davis, California.
(c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soils, Univ. of Calif., Los Angeles 24, Calif.
(d) Experimental; applied research.
(e) Factors in watershed management that influence the dispostion of precipitation and yield of usable water. Soil and water factors in change of vegetation from brush to grasses and forbs, control of consumptive use by phreatophytes, experiments in watershed paving.

(1058) SOIL PHYSICAL CONDITIONS IN RELATION TO IRRIGATION.

   (b) Coordinated laboratory studies with field observations of water transfer in soils.
   (c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soils, Univ. of Calif., Los Angeles 24, Calif.
   (d) Continuing laboratory and field studies; basic and applied research.
   (e) Study of the soil properties and management practices which affect the flow of water into and through soils, the storage of water in soils and evaporation from soil, and soil compaction.
   (h) "Use of Infiltration Equation Parameters to Evaluate Infiltration Differences in the Field", D. Swartzendruber and M. R. Huberty, Trans. Amer. Geophys. Union (in press).

(1303) HYDRAULIC CHARACTERISTICS OF IRRIGATION DISTRIBUTION SYSTEMS.

   (b) Laboratory project, cooperative with College of Engineering, Univ. of Calif., Los Angeles 24, Calif.
   (c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soils, Univ. of Calif., Los Angeles 24, Calif.
   (d) Basic and applied research.
   (e) Continued analysis of the operational characteristics of pipe water distribution systems. Principally concerned with automation in the operation of low pressure systems.
   (g) Have made theoretical and practical analyses of potential transient phenomenon in systems with pressure controlled by float valves.
   (h) "Investigation of a Semiclosed Irrigation Distribution System", Yehuda Volfenson, M.S. Thesis, 1956.
"Transient Analysis of a Semiclosed Irrigation Distribution System", Jack O. Hildebrand, M.S. Thesis, 1957.

(2504) DYNAMICS OF WATER FLOW IN SATURATED SOILS, AND ITS APPLICATION TO THE DESIGN OF DRAINAGE SYSTEMS.

   (b) Laboratory project - coordinated with similar work of Dept. of Irrigation, Davis, Calif.
   (c) Prof. A. F. Pillsbury, Chairman, Dept. of Irrigation and Soils, Univ. of Calif., Los Angeles 24, Calif.
   (d) Experimental; applied research.
   (e) Mechanics of flow of water through soil and into drainage facilities.
   (g) Have determined effects of wetting expansion on the entry of water into drain tile. Material is being prepared for publication. Data are being gathered on maximum and mean yield of drainage systems.
   (h) "Discharge of Tile Drainage Systems in an Irrigated Area of California", A. F. Pillsbury, L. O. Weeks, J. R. Spencer, and R. C. Reeve. Trans. Amer. Geophys. Union 37:474-476, 1956.

UNIVERSITY OF CALIFORNIA, College of Engineering, Fluid Mechanics Laboratory.

Inquiries concerning the following projects should be addressed to Prof. J. W. Johnson, Dept. of Engineering, Univ. of Calif., Berkeley 4, Calif.

(38) STRUCTURES EXPOSED TO WAVE ACTION.

   (b) National Science Foundation.
   (d) Experimental; laboratory.
   (e) To obtain experimental data for the design of offshore structures. Present work involves the measurement of forces exerted on model elements subjected to wave action.
   (f) Completed.
   (h) "Wave Forces on Piling", M.S. Thesis in Mechanical Engineering by M. A. Hall, January 1957.

(40) FLOW CHARACTERISTICS OF GAS-SOLIDS MIXTURES.

   (b) Laboratory project.
   (d) Experimental; basic and applied research, design.
   (e) The flow characteristics of a gas-solids mixture (alumina catalyst and air) have been investigated in a 17 mm I.D. glass conduit for various gas flow and solids flow rates. Pressure drops across test sections have been accurately measured for a series of air flow rates in which the solids to air ratio is varied from zero to 11.0 pounds of solids per pound of air. The solids are introduced into the flow system through a mixing nozzle fed by a slide valve controlled weighing tank, and have a size distribution varying from particles less than 10 microns to particles greater than 220 microns. Investigation on the metering of solids-gas mixtures by nozzle and Venturi-tubes has been carried out. Studies on the heat transfer to flowing gas-solids mixtures have been carried out and are being continued. Metering and heat transfer studies are being continued using fixed size glass spheres.
   (g) Equipment for the study of the heat transfer characteristics of flowing mixtures is being modified to study the behavior of very dense mixtures.
   (h) "Heat Transfer to Flowing Gas-Solids Mixtures in a Circular Tube", by Leonard Farbar and Morgan J. Morley, Industrial Engineering Chemistry, Vol. 49, p. 1143, July 1957.
"Heat Transfer to Flowing Gas-Solids Mixtures Using Solid Spherical Particles of Fixed Size", by C. A. Depew, M. S. Thesis, 1957, Univ. of Calif. Library, Berkeley, Calif.

(280) SEDIMENT TRANSPORT.

   (b) Laboratory project and U. S. Corps of Engineers.
   (d) Experimental and theoretical.
   (e) Various fundamental problems in relation

to sediment transport have been studied, and efforts have been made to apply the results of research to solve practical problems.

(g) The changes in the bed-load relationships are studied as they result from high sediment concentrations near the bed. No results are available as yet.

(529) LITTORAL SEDIMENT FLOW ON A BEACH.

(b) Beach Erosion Board, Dept. of the Army, Washington, D. C.

(d) Field, laboratory; experimental and theoretical research.

(e) The object of this investigation is to determine the mechanics of sand transport on beaches along the coast of California, particularly in the vicinity of San Francisco. Special attention has been given to Point Reyes Beach 35 miles northwest of San Francisco, but in the past 15 months 15 beaches both north and south of San Francisco have been studied. The beaches are occupied at intervals of 6 to 12 weeks. Samples are taken for grain size variations and profiles are measured to determine cut and fill. On Point Reyes beach the sands are coarse, ranging from a mean of 560 microns in October to 770 in February. The general variation in standard deviation of the samples on the beach at any one time is 20 to 25 percent of the mean grain size for the beach. The sediments at all times are more poorly sorted than most beaches, as the coefficient of sorting lies generally between 1.27 and 1.30. The sediments on the lower foreshore are more coarse grained and are better sorted than the sediments on the upper foreshore or berm. The beach has numerous cusps which have an interval ranging between 60 and 250 feet, with an average of 160 feet. The cusp interval seems to vary with grain size being small (100 feet) for median grain size of 750 microns and large (200 feet) for median grain size of 550 microns. Individual cusps may advance or retreat as much as 160 feet within an interval of 6 weeks. The beach may cut or fill at a rapid rate. Fills of as much as one foot within a tide have been observed.

(h) "Changes in Configuration of Point Reyes Beach, 1955-1956", by Parker D. Trask, Beach Erosion Board Technical Memorandum 91, November 1956, 63 pages.

(1554) SEA WATER RESEARCH.

(b) State of California.

(d) The several investigations for demineralizing sea water carried on during the past year are: (1) Solar distillation; (2) low-temperature difference method; (3) use of high liquid pressures in combination with appropriate permeable membranes (osmotic pressures); (4) thermodynamic analyses of separation methods; and (5) ion exchange using heat for regeneration.
Solar distillation, low-temperature

difference, osmotic pressures, and ion exchange are experimental. The thermodynamic analysis is a theoretical investigation.
The thermodynamic analysis should be regarded as basic research only. The other three projects should be classified as applied research.

(e) The purpose of this investigation is to discover whether there is available any method for the large-scale, low-cost demineralization of sea water.
Operation of the solar stills was continued, with an additional wick-type still in operation. Also, a small project was carried out on the use of paraffin wax as a heat absorber and storage material.
The data on the large low-temperature-difference plant is being extended to the study of carry-over of gas and brine.
The U. C. L. A. program of work on the use of reversed osmosis was continued and a larger unit has been constructed. Work was initiated at Berkeley on a means for constructing high strength osmotic membranes. The Berkeley development consists of the use of bundles of parallel fibers with flow parallel to the fibers. By using synthetic materials which swell in water, it has been possible to get down to pore sizes of the order of a few Angstroms. Present efforts are directed toward reducing these pore sizes.

(g) Detailed results may be obtained from progress reports published by the Institute of Engineering Research.

(h) "Vacuum Flash Distillation of Sea Water", E. D. Howe, A.S.M.E. Advance Paper (June 1957).
"Conversion of Saline Water", E. D. Howe, presented at Sectional Meeting of American Water Works Association, Oct. 1957, San Jose, Calif.

(1823) THE MECHANICS OF BOTTOM SEDIMENT MOVEMENT WITH OSCILLATORY WAVES.

(b) Beach Erosion Board, Dept. of the Army.

(d) Experimental.

(e) To obtain experimental information on the criterion for initial and general movement of bottom sediment by wave action. Prototype conditions of the relative motion of water and bed were simulated by use of an oscillating plate in still water.

(g) A theoretical solution has been found for the turbulent boundary layer flow along an oscillating surface and was empirically checked for the smooth bottom. A solution has been found for the rough wall, but must be checked for various different types of roughness.

(1824) BEHAVIOR OF AIR ABOVE MECHANICAL OCEAN WAVE MODEL.

(b) National Science Foundation.

(d) Experimental; basic research.

(e) Measurement of velocity distributions in air above a mechanical model of long and

short crested ocean waves as a function of wind velocity, wave height and wave length. Drag forces as a function of distance from wave plane to a rigid ceiling determination.

(f) Completed.

(h) "Direct Shear Stresses and Air Velocity Profiles on a Mechanical Wave Boundary", G. H. Moore and A. D. K. Laird, Trans. A. G. U., Vol. 38, No. 5, October 1957.

(1825) WIND WAVES IN SHALLOW WATER.

(b) Beach Erosion Board, Dept. of the Army.

(d) Experimental.

(e) To obtain experimental information on the factors of wind velocity, wind duration, water depth, bottom slope, and bottom roughness as related to wave generation and wind tide produced in shallow water of limited extent. A glass wall channel 70 feet long, 15 inches deep, and 12 inches wide has been constructed for this study.

(h) "Effect of Bottom Roughness on Wind Tide in Shallow Water", by E. G. Tickner, Beach Erosion Board Tech. Memo, No. 95, 1957. "Laboratory Study of Wind Tides in Shallow Water", O. J. Sibul and J. W. Johnson, Journal of the Waterways and Harbors Div., ASCE, April 1957.

(1829) STUDY OF INCLINED GAS-LIQUID FLOW IN TUBES.

(b) Laboratory research project.

(d) Experimental and theoretical; basic research.

(e) Collection and correlation of data on several diameters of tubing at inclinations from horizontal to vertical.

(f) Suspended.

(g) One inch diameter smooth and rough tubes tested. Paper in preparation.

(h) "Two-Phase Flow in Rough Tubes", by D. Chisholm and A. D. K. Laird. Presented at the semi-annual meeting of ASME in San Francisco, July 1957.

(1830) MEASUREMENT OF THE DISTRIBUTION OF A GAS AND TWO LIQUIDS IN A POROUS MEDIUM BY X-RAY TECHNIQUES.

(b) Laboratory project.

(d) Experimental; applied research.

(e) Development of a calibration and measurement method for the distribution of three or more materials in a laboratory sample of sandstone.

(f) Completed.

(h) Paper in preparation.

(2058) STUDY OF EXCHANGE CHARACTERISTICS IN A TURBULENCE COLUMN.

(b) Laboratory project.

(d) Experimental.

(e) Exchange of various properties are studied and compared for various properties in a column with reproducible turbulence pattern.

(g) The column is constructed. Sediment distributions are observed for various degrees

of turbulence. One of the major results is the fact that a high velocity jet is much less efficient in creating large scale turbulence than wall friction in open channel flows.

(2059) STUDY OF BED-LOAD MOTION IN A FLOW SUBJECTED TO COMPOSITE FRICTION.

(b) Laboratory project.

(d) Experimental.

(e) A granular bed is developed between a system of obstructions such as piles. It is attempted to determine the part of the flow resistence which determines the rate of sediment motion.

(g) In a thesis study limitations are investigated to the independence of frictional drag forces.

(2062) STRESS-STRAIN RELATIONSHIPS FOR SHEAR IN A SAND-WATER MIXTURE.

(b) Laboratory project.

(d) Experimental.

(e) The relationship is determined in an especially constructed rotating shear device for various normal pressures. The results will be used to predict the behavior of a granular stream bed subjected to high shear by a flow.

(g) Results have been obtained. Work is now concentrating on the analysis of the results.

(2063) METHODS OF DETECTING AND TRACING THE MOVEMENT OF GROUND WATER.

(b) U. S. Bureau of Reclamation.

(d) Experimental; applied research.

(e) This study has as its objectives study of velocity variations observed in tracing the flow of liquids through porous media, development of methods and tracers for field determination of water movement underground, and application of these methods to location and measurement of seepage from canals.

(g) Dispersion phenomenon for laminar flow through porous media relationships determined by laboratory studies were applied to radial flow systems. The results were checked by recharging and sampling from a confined aquifer. Formation constants were determined in these tests.

(h) "Studies of Dispersion in a Radial Flow System", by Leung Ku Lau, W. J. Kaufman and D. K. Todd, Institute of Engineering Research Series No. 93, Issue No. 3, Univ. of California, Berkeley, p. 44, July 1957.

(2261) WAVE REFRACTION RESEARCH.

(b) Beach Erosion Board, Dept. of the Army.

(d) Laboratory project.

(e) In shallow water the velocity of a water gravity wave depends upon the depth of water as well as upon the length of the wave. When it travels in shoaling water it bends. This refraction changes the

wave height and direction. Powerful graph-
ical and analytical tools are available
for use by the engineers; however, there
is an almost complete lack of evidence as
to their accuracy. The purpose of this
contract has been to perform laboratory
experiments to check the validity of the
techniques used in practice. The first
series of tests were performed in a ripple
tank; these showed that the techniques
were fairly reliable from a practical
standpoint. A series of tests have been
made in a model basin 150 ft by 64 ft by
2-1/2 ft deep. The results of these tests
have been written up. Tests are being con-
ducted on the formation of multi-crest
waves as periodic waves pass into shoal
water.

(h) "A Ripple Tank Study of Wave Refraction",
by G. C. Ralls, Jr., Journal, Waterways
Division, Proc. ASCE, Vol. 88, Paper No.
911, 19pp, March 1956.
"Model Study of Wave Refraction", by R. L.
Wiegel and A. L. Arnold, Journal, Water-
ways Division, ASCE (in press).

(2262) ANCHORING FORCES RESEARCH.

(b) California Research Corporation.
(d) Laboratory project.
(e) Model studies are being made of the forces
in mooring lines of a vessel anchored at
sea. Tests are being made with both uni-
form and non-uniform wave conditions.
(f) Completed.
(h) "Model Studies of the Dynamics of an LSM
Moored in Waves", by R. L. Wiegel, K. E.
Beebe and R. A. Dilley, Proceedings of
the Sixth Conference on Coastal Engineer-
ing (in press).

(2265) FORCES ON ACCELERATED CYLINDERS.

(b) Engineering Foundation and Laboratory
project.
(d) Experimental; basic research.
(e) Measurement of drag coefficients and flow
configurations about cylinders during
accelerated motion in fluids as related to
wave forces as cylinders.
(f) Completed.
(g) Constant acceleration drag forces measured
for three cylinders. Paper in preparation.

(2266) HYDROLOGIC INVESTIGATIONS OF SMALL DRAINAGE
BASINS IN CALIFORNIA.

(b) U. S. Bureau of Public Roads.
(d) Analytic study; applied research and de-
velopment.
(e) The purpose of this investigation is to
summarize streamflow records in California,
to classify records on the basis of homo-
geneous areas for analysis, to test the
adequacy of methods for estimating flood
flows in California from those developed
in other parts of the country, and, if re-
quired, explore new methods of estimating
flood flows.
(f) Completed.

(g) This study is concerned with practical pro-
cedures for estimating flood magnitude
needed to design highway drainage struc-
tures in Northern California. Records of
unregulated streamflow ten years or more
in length were selected and classified by
Soil Conservation Service Areas. Most of
these were found for the problem area en-
compassing the western slope of the Sierra
Nevada Mountains.
A series of parameters representative of
the climatic and topographic characteristics
of the basins were developed. Various com-
binations of these were tried in multiple
regression analyses to estimate 10-year
floods. Drainage area, mean annual pre-
cipitation, and elevation factor gave the
minimum standard error of estimate. The
equation developed from the multiple re-
gression analysis was tested on independent
data and proved satisfactory. Graphical
analysis of reselected data gave best re-
sults with drainage area and precipitation
intensity as parameters.
The results apply only to the specified
area; however, similar analyses should
yield comparable results for other areas
in California.
(h) "Estimation of Flood Peaks in the Sierra
Nevada Mountains, California", by David K.
Todd and K. H. Ateshian, Institute of
Engineering Research, Series No. 102, Issue
No. 1, Univ. of Calif., Berkeley, 87 pp.,
Nov. 1956 (available on request).

(2505) EFFECT OF SEDIMENT DISTRIBUTION IN STREAM
CHANNELS.

(b) University project.
(d) Experimental; basic research.
(e) Alluvial flows in channels with artifi-
cially secured banks are studied system-
atically for their tendency to meander as
expressed by the development of alternate
bars. It is the aim of this study to
develop criteria for stability.
(g) The important parameters seem to be the
Froude number, the depth-width ratio and
the size and uniformity of the bed sedi-
ment.

(2506) SEDIMENT MOTION IN SILT CARRYING STREAMS.

(b) National Science Foundation.
(d) Experimental; basic research.
(e) An alluvial stream with a bed material in
the sand sizes or coarser follows relation-
ships generally called bed-load formulas.
This study tries to find what the corre-
sponding laws are if the bed sediment con-
sists mainly of particles in the silt sizes
as fines.
(g) The transport of silts coarser than 5 mi-
crons seem to follow laws very similar to
those for fine sand.

(2507) SAND DEPOSITS IN CANALS.

(b) U. S. Bureau of Reclamation.
(d) Experimental; basic research.

(e) The relationships are sought governing the deposit of various sediment sizes and types in lined canals under various flow conditions. Of particular interest is any resulting change of the effective channel roughness and of its flow capacity.

(2508) SHIP WAVES IN WATERWAYS.

(b) Laboratory project.
(d) Experimental.
(e) To obtain experimental information on the characteristics of waves generated by ships in shallow water. Such information is of value in the problem of wave wash and bank erosion in waterways. Ship models are towed at various speeds in water of various depths and the wave characteristic measured at various distances from the sailing line.
(h) "Ship Waves in Navigation Channels", J. W. Johnson, Proceedings of the Sixth Conference on Coastal Engineering, 1957.

(2509) NON-STEADY FLOW ANALOGY.

(b) Dept. of Water Resources, State of Calif.
(d) Experimental; applied research.
(e) By means of an electric analog model of the San Francisco Bay and the Sacramento-San Joaquin Delta Region, the feasibility of barriers and channel works is being investigated, with the purpose of providing a greater flow of fresh water southward in the Central Valley.
(f) Completed.
(g) The tidal amplitude changes which should be expected due to the imposition of each of several proposed salinity barriers have been predicted, and are in accordance with analytic results where these are available. Prototype tidal amplitudes, phases, and currents were duplicated in the analog model within three to five percent at all major points. A new type of square-law resistor has been developed which takes into account changes in the water depth.
(h) "The Theoretical Basis for Non-Linear Electric Analogs for Open Channel Flow", James A. Harder, Inst. of Engineering Research Univ. of Calif., Berkeley 4, Calif.
"An Electric Analog Model Study of Tides in the Delta Region of California", James A. Harder, Inst. of Engineering Research, Univ. of Calif., Berkeley 4, Calif.

(2749) SELF-DRAINING STILLING DEVICE FOR PIPE CULVERTS.

(b) Contra Costa County.
(d) Experimental; development.
(e) A stilling and spreading device for the discharge from high-velocity culvert flows is developed by the use of baffle sills in a trapezoidal channel. The device is self draining, avoiding danger to children and breeding of mosquitoes.
(f) Completed.
(g) General design criteria are developed and given to the sponsor in form of a report.

(h) "Development of the County of Contra Costa Culvert Outfall Energy Dissipator", by S. R. Keim, Inst. of Engineering Report Series ES5795, Issue 1, Sept. 1956.

(2750) DROP STRUCTURE WITH SELF-DRAINING STILLING BASIN.

(b) U. S. Dept. of Agriculture.
(d) Experimental; development.
(e) Stilling basins with permanent pools are dangerous to playing children and make mosquito breeding places, both undesirable in inhabited areas. A stilling device is developed which is self draining and which is efficient at widely varying tailwater conditions.
(g) Solutions for some particular cases have been found and are constructed. Solutions for a wider variety of cases are being developed.

(2751) DEVELOPMENT OF A TRASH RACK AND INTAKE STRUCTURE TO BARREL TYPE SPILLWAYS.

(b) U. S. Dept. of Agriculture.
(d) Experimental; development.
(e) Barrel type spillways can highly increase the effectiveness of small flood control retaining basins, if they can be prevented from plugging by floating trash. An effective intake and trash rack is developed from the viewpoint of clogging.
(g) A syphon-type intake with low intake velocity appears to provide for the most desirable hydraulic and trash conditions.

(2752) REVOLVING FISH SCREEN.

(b) California Department of Fish and Game.
(d) Experimental.
(e) Development and testing of a revolving fish screen which continuously waves in front of a hydraulic cleaning device.

(2753) HYDRAULIC BREAKWATER.

(b) Office of Naval Research, Dept. of the Navy.
(d) Experimental; applied research.
(e) Determination by model tests of the mechanisms by which hydraulic breakwaters dampen water gravity waves.
(g) Three dimensional tests in a model basin show that the effect of wave refraction due to the currents generated by the hydraulic breakwater is of primary importance. For certain conditions the area in the lee of the breakwater can be made to be almost free of waves, while for other conditions the waves behind the breakwater will be higher than if there were no hydraulic breakwater in operation.
(h) "Model Hydraulic Breakwater Studies", by C. M. Snyder, preliminary report, Univ. of Calif., Inst. of Eng. Res., Tech. Rept. 104-1, 30 pp, April 1957.
"Chipboard Hydraulic Breakwater", by R. A. Dilley, Univ. of Calif., Inst. of Eng. Res., Technical Report 104-2, 53 pp, August 1957.

(2754) UNDERWATER MISSILES.

    (b) U. S. Naval Ordnance Test Station, China
        Lake, Calif.
    (d) Experimental; applied research.
    (e) The determination of the trajectories of
        missiles fired vertically under the influ-
        ence of water gravity waves and currents.
    (g) Analysis of data has been completed.

(2755) DEVELOPMENT OF METHODS TO TAG SEDIMENTS BY
       RADIOACTIVE MATERIALS.

    (b) U. S. Corps of Engineers.
    (d) Experimental and theoretical.
    (e) Radioactive materials are sought which can
        be permanently attached to sediment grains
        from the sand to the clay sizes. The in-
        strumentation is to be developed by which
        these tagged sediments can be observed in
        prototype water courses, particularly in
        the San Francisco Bay.
    (g) Scandium and gold have been found to be the
        best suited materials. The instrumenta-
        tion for field detection of radio activity
        is being developed.

(2756) WATER RESOURCES DEVELOPMENT BY CONJUNCTIVE
       OPERATION OF SURFACE AND GROUND-WATER
       RESERVOIRS.

    (b) Laboratory project.
    (d) Theoretical; operation and development.
    (e) Utilization of ground-water storage capac-
        ity is imperative to future California
        water resources development. Methods for
        economically developing river basins to a
        high percentage of total available by means
        of conjunctive operation of surface and
        ground-water reservoirs are being investi-
        gated.
    (g) Conjunctive operation permits development
        of river basins similar to those of Cali-
        fornia Central Valley to about the eighty
        percent level where surface development
        with only supplemental ground-water pumping
        is limited to about sixty percent.
    (h) Report submitted for publication.

(2757) INCIDENTAL ARTIFICIAL RECHARGE OF GROUND-
       WATER RESERVOIRS.

    (b) Water Resources Center, Univ. of Calif.
    (d) Applied research.
    (e) Recharge is one of the chief problems in
        ground-water reservoir operation. Deter-
        mination of the various characteristics and
        potentialities of incidental recharge as a
        tool in water resources development by
        conjunctive operation of surface and
        ground-water reservoir operation.
    (g) Studies indicate that incidental artificial
        recharge can, in many agricultural areas,
        provide the major portion of required re-
        charge provided the ground-water service
        area and the surface supply service area
        have a large overlap or area in common.
    (h) Publication being prepared.

UNIVERSITY OF SOUTHERN CALIFORNIA, Research Founda-
tion for Cross-Connection Control.

Inquiries concerning Projects Nos. 49 and 2270
should be addressed to Dr. K. C. Reynolds,
Supervisor, Research Foundation for Cross-Connec-
tion Control, University of Southern California,
Los Angeles 7, Calif.

    (49) RESEARCH FOUNDATION FOR CROSS-CONNECTION
        CONTROL.

    (b) Laboratory project.
    (d) Experimental research and field investiga-
        tions; basic research.
    (e) To determine by proper research the rela-
        tive value and protection afforded by
        various backflow prevention devices.
    (g) Establishment of standardized laboratory
        and field test procedures and minimum
        specification requirements for backflow
        prevention equipment and continuous evalua-
        tion and improvement of such procedures
        and specifications.

(2270) BACKFLOW PREVENTION.

    (b) Dept. of Water and Power, City of Los
        Angeles, Calif.
    (d) The Department, in order to be advised on
        backflow prevention problems, has entered
        into a contract with the University from
        December 1954 to December 1957.
    (e) This contract involves the following:
        (a) Consulting services regarding backflow
        prevention installations and other hydraul-
        ic problems; (b) preparation of specifica-
        tions covering the design, material, and
        operational requirements for backflow pre-
        vention units; and (c) maintenance of a
        laboratory for testing backflow prevention
        devices and other hydraulic equipment for
        the Department.
    (h) Quarterly progress reports to the Depart-
        ment. Preliminary draft of proposed
        specifications being revised.

UNIVERSITY OF SOUTHERN CALIFORNIA, School of
Engineering.

Inquiries concerning Projects Nos. 2273 and 2758
should be addressed to Dr. K. C. Reynolds, School
of Engineering, University of Southern California,
Los Angeles 7, Calif.

(2273) FREE OVERFALL OF A CIRCULAR CONDUIT.

    (b) Graduate research.
    (d) Experimental study of the free overfall of
        two partially filled circular conduits,
        0.655 and 0.333 ft in diameter, laid on
        mild slopes.
    (e) For various rates of flow the profile of
        the water surface is being observed; the
        calculated critical depth is being located;
        correlation between the measured depth at
        the drop off and the rate of flow is being
        investigated.

(h) Master's thesis in preparation by C. E. Robinson.

(2758) FLOW IN AN OPEN CHANNEL SUBJECTED TO TIDES.

(b) Southern California Edison Co., 601 West 5th Street, Los Angeles, Calif.
(d) A model study of flow in a proposed canal to carry cooling water to a steam station generating electricity. The initial capacity of the station will be 400,000 KW.
(e) Water is to be conveyed in a canal from Hueneme Harbor with its varying tides through a 25,000-foot long canal to the steam plant where dependable flows of 200, 400, 600, 800 cfs must be available as the generating units are added to the line. In accordance with a contract dated May 27, 1957 between Southern California Edison Co. and Professors Reynolds and Springer a model has been built with a horizontal scale of 1 to 150 and a vertical scale of 1 to 30. The tide reproducing mechanism permits a number of consecutive tides to be created. Ten water level indicator units will permit the determination of water levels at frequent intervals. From the model it will be possible to predict high and low water levels throughout the length of the canal thereby discovering any unusual water level situations; to discover any sections where the flow is unfavorable.
(g) The test runs were begun as of Nov. 1957.

CARNEGIE INSTITUTE OF TECHNOLOGY, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1834, 2064, 2275, 2276, and 2759 should be addressed to Dr. T. E. Stelson, Dept. of Civil Engineering, Carnegie Institute of Technology, Pittsburgh 13, Pa.

(1834) AIR-WATER FLOW.

(b) Laboratory project.
(d) Theoretical and experimental.
(e) An investigation to determine the amount of air that can be carried by flowing water. Experiments are conducted with free water jets and with air-water mixtures flowing in pipes at different slopes.

(2064) VIRTUAL MASS.

(b) Laboratory project.
(d) Experimental and analytical.
(e) Measurement of virtual mass of bodies in fluids with free and fixed boundaries.
(h) "Virtual Mass and Acceleration in Fluids", by Thomas E. Stelson, J. M. ASCE, and Frederick T. Mavis, M. ASCE, Trans. Amer. Society of Civil Engineers, Vol. 122, p. 518-525, 1957.

(2275) FLOW OF LIQUID-SOLID MIXTURES.

(b) Laboratory project - Freeman Fellowship.

(d) Basic experimental and analytical research for doctoral thesis.
(e) Determination of energy losses, solid and liquid velocities, concentration of solids, and characteristics of flow.

(2276) UNSTEADY FLOW THROUGH CONDUITS, WEIRS AND ORIFICES.

(b) Laboratory project.
(d) Experimental and analytical for undergraduate thesis.
(e) Analysis of steady-flow characteristics from measurements with unsteady flow.

(2759) FLOW INTO VERTICAL SHAFTS.

(b) Laboratory project.
(d) Experimental and analytical.
(e) Evaluation of the characteristics of flow entering a vertical shaft for various geometric and hydraulic conditions.

COLORADO SCHOOL OF MINES, Civil Engineering Dept.

Inquiries concerning Projects Nos. 2280 to 2282, incl., should be addressed to Prof. Henry A. Babcock, Colorado School of Mines, Golden, Colo.

(2280) DEEP NOTCH WEIRS.

(b) Laboratory project.
(d) Experimental; basic research.
(e) The purpose of the work is to determine the relationship between the discharge coefficient, and the ratio of crest length to head for sharp crested weirs with end contractions.

(2281) THE EFFECT OF GRAIN SIZE DISTRIBUTION AND VOID RATIO ON PERMEABILITY.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Samples of definite size distribution will be fluidized, and variation of pressure gradient and sorting action will be observed.
(f) Suspended.

(2282) PULP DENSIMETER.

(b) Laboratory project.
(d) Design and development.
(e) The device will measure continuously the density of liquid-solid mixtures in a pipe without being influenced by fluctuations in the velocity of flow.
(f) Completed.
(h) Report will be released when patent arrangements are completed.

COLORADO STATE UNIVERSITY, Civil Engineering Sec.

(55) SNOW COURSE MEASUREMENTS AND FORECAST ANALYSIS.

(b) Soil and Water Conservation Research Branch, Colorado Agricultural Experiment Station, Bureau of Reclamation, State Engineer of New Mexico, and State Engineer of Wyoming.
(c) Mr. H. J. Stockwell, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Field investigations; applied research.
(e) Systematic measurements of depth and water content of snow at high elevations in Colorado mountain areas for the purpose of forecasting the runoff of the principal rivers of the state in the interest of irrigation, power, domestic supplies, and other uses. The use of electrical resistance soil moisture units is being tested to determine a factor of soil moisture deficiency for water supply forecast purposes.
(g) Snow measurement data are correlated with runoff. Once the relationship is established, the snow measurement data are used to predict the runoff for the coming season.
(h) Colorado Agricultural Experiment Station General Series Papers--Monthly Snow Survey reports for the Rio Grande, Colorado and Platte-Arkansas Drainage Basin.

(821) GROUND-WATER FLUCTUATIONS AND THEIR RELATION TO PUMPING.

(b) Colorado Agricultural Experiment Station.
(c) Mr. W. E. Code, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Field investigation.
(e) This is a continuing project. Work consists of semi-annual measurements of the water table in about 260 observation wells in Arkansas and South Platte Valleys in Colorado. Observation wells are strategically located in pumping areas. Data on power consumption are also gathered for comparison with water table elevations. The work is being coordinated with the Ground Water Branch, U.S.G.S.
(g) Water tables have declined significantly in all areas in the last 3 years of subnormal precipitation.
(h) A manuscript is being prepared for a Station bulletin on the work to date which started in 1929. Graphs of water table fluctuations will be shown.

(1074) HYDRAULICS OF STILLING BASINS.

(b) U. S. Bureau of Public Roads.
(c) Mr. G. L. Smith, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Experimental; applied and fundamental.
(e) To obtain generalized design information for stilling basins utilizing the principle of vertical dissipation of kinetic energy of flowing water and control of scour by well graded aggregate. The stilling basin constitutes a pre-shaped scour hole in a simulated stream bed in which various quantities of graded aggregate are placed.

(g) Initial studies using two-dimensional jets have been completed, as well as circular non-submerged jets, both vertical and cantilevered. The variables considered were the depth of pool, the fall velocity of the erodible material, the size of jet, the momentum of the jet. The depth and volume of scour depends upon the depth of water in the stilling basin, the size or momentum of the jet, and the size and gradation of the bed material. Pit-run, graded rip-rap proved to be much more effective than any size of rip-rap of a narrow size range. Prototype installations were made for the two-dimensional case in the field in 1955 and the various design factors studied. Qualitatively these confirm the experimental results. For the three-dimensional case, the method of placement and location of rip-rap relative to the location of the impinging jet at bed surface have been investigated in a model. The dimensions of a pre-shaped scour hole for the case of the cantilevered circular jet have been determined from experimental data.
(h) "Stabilization of Thompson Lake Outlet Channel", by T. T. Williams, Master's Thesis, Nov. 1956.
"Principles of Energy Dissipation in Erosion-Control Structures", by M. L. Albertson and G. L. Smith, Colorado State University, Civil Engineering Dept. Report CER57MLA4, January 1957.
"An Analysis of Scour Below Culvert Outlets", by G. L. Smith, Master's Thesis, June 1957.

(1567) BEHAVIOR OF SEAPLANE HULLS IN SIMPLE SEAS.

(b) Bureau of Aeronautics, Navy Department.
(c) Mr. E. F. Schulz, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.
(d) Experimental; applied research.
(e) Two model seaplanes were towed at different headings to a simple wave front. The responses of the model to the waves were measured from movies taken from the front and side during the experiments.
(f) Completed.
(g) The important parameters determining operating in the pre-hump speed ranges were the effective towing ratio, relative hull length and damping ratio. Increasing the hull length-to-beam ratio from 8 to 12 improves the seaworthiness of the seaplane.
(h) "Model Tests to Predict the Seaworthiness of Seaplane Hulls", by E. F. Schulz, Colo. State University, Civil Engineering Dept. Report CER57EFS1, 60 p., January 1957.

(1570) FLOW PATTERNS ON LANDING IMPACT OF SEAPLANES.

(b) Bureau of Aeronautics, Dept. of the Navy.
(c) Mr. E. F. Schulz, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.
(d) Experimental.
(e) To record the force-time history of the

impact of V-wedges with angles of dead rise 3° to 50°, and two "constant force" hulls. To record the flow field development by photographic means as the wedges are dropped into a tank of bentonites, or zero-buoyancy bubbles, and water.

(f) Completed.

(g) The force-time histories have been recorded, and indicate the earlier work along similar lines by MIT and Colorado State University employed too small a tank. Bentonite proved unsatisfactory as a material for use in obtaining photographs of the flow field. Computations of the apparent mass as a function of immersion depth for various V-wedges are being completed. Zero buoyancy bubbles located in the water of the drop-tank permitted photographs of the path lines of the bubbles to be made for each impact of a V-wedge.

(h) "Deceleration During Impact of Seaplane Hulls on a Water Surface", by Bernard d'Utruy, Master's Thesis, August 1957. Report to sponsor in progress.

(1837) SEALING OF IRRIGATION CANALS BY BENTONITE SEDIMENTING.

(b) U.S.D.A. Agricultural Research Service, U.S.D.I. Bureau of Reclamation, various irrigation companies and districts.

(c) Mr. R. D. Dirmeyer, Jr., Civil Engineering Sec., Colorado State University, Fort Collins, Colo.

(d) Applied research and development, both laboratory and field investigations.

(e) The sedimenting method involves the use of bentonite suspensions in water. The sealing is accomplished by the bentonite seeping into the cracks and voids of the pervious canal bed material. The technique depends greatly upon field conditions of each specific case. Most recent developments show the possibility of introducing various chemical products to supplement, or even in lieu of, the bentonite.

(g) Varying degrees of success have been achieved, ranging from no reduction to 90% reduction in seepage. Further results await evaluation of improved techniques and long-term effectiveness. In most installations the amount of water saved even during only the first season has more than paid for the operation costs.

(h) "Report of Sediment Lining Investigations Fiscal Year 1956", by R. D. Dirmeyer, Jr., Colorado State University, Civil Engineering Dept. Report CER56RDD17, August 1956. "Use of Colloidal Clay Sediments in Sealing Irrigation Canals", by R. D. Dirmeyer, Jr., International Commission on Irrigation and Drainage, Third Congress, R.5, Question 7, pp. 7.76-7.96, February 1957.

(1838) BEHAVIOR OF MODEL SHIP HULLS IN AN OBLIQUE SEA SYSTEM.

(b) David Taylor Model Basin through the Office of Naval Research, Department of the Navy.

(c) Mr. E. F. Schulz, Civil Engineering Sec.,

Colorado State University, Fort Collins, Colo.

(d) Experimental; applied research.

(e) A five-foot model tanker was towed at five different headings to a simple wave front. The responses of the model to the waves were measured from movies taken from the front and side during the experiments.

(f) Completed.

(g) The important parameters affecting the model motions were found to be the effective tuning ratio and the relative wave length. Amplitudes of motion were found to be as much as five times greater than the associated wave function when the tuning ratio was near unity. For a particular tuning ratio the amplitude parameters increased with increasing wave length up to approximately twice the hull length.

(h) "Model Tests with a Tanker in Oblique Seas", by E. F. Schultz, T. T. Williams and R. M Ralston, Colorado State University, Civil Engineering Dept. Report CER57EFS2, 56 p., January 1957.

(1839) THEORY AND DESIGN OF STABLE CHANNELS IN ALLUVIAL MATERIALS.

(b) Cooperative project sponsored by U.S.G.S., Corps of Engineers, U.S.B.R., Colorado State University, and the University of Wyoming.

(c) Mr. D. B. Simons, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.

(d) Experimental (based on field data), basic research.

(e) This project involves a field study of stable channels in alluvial material. The purpose of the research is to investigate the validity of the regime theories as developed in India; to investigate, expand and possibly improve the tractive force method of stable channel design; and to relate the regime theories to the tractive force theory insofar as possible.

(f) Completed.

(g) The usefulness of the regime and tractive force theories was verified. The range of applicability to design of both theories was expanded. Methods of combining the more useful concepts of each of these theories and applying them to design problems are illustrated. Problems that will require further study are cited.

(h) "Theory and Design of Stable Channels in Alluvial Material", by D. B. Simons, Ph.D. Dissertation, 1957.

(2066) STUDY OF OPEN CHANNEL CONSTRICTIONS IN A SLOPING FLUME.

(b) U. S. Bureau of Public Roads.

(c) Dr. H. K. Liu, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.

(d) Experimental; applied.

(e) The study is divided into two stages. The first stage, which has been finished, was to study the backwater caused by the

constriction in a tilting flume having a rigid bottom. The second stage of the study, which is in progress, is to study the effect of an alluvial bed on the backwater and also the maximum scour around the abutments. The experimental work is conducted in a 160 foot long, 8 foot wide flume. Both the sediment and the water are recirculated in this system. A uniform flow is established before the abutments are in place. The change of water surface configuration and the change of bed configuration are measured throughout the testing period. The degree of contraction caused by the abutments varies from 0.5 to 0.1.

(g) The maximum scour depends primarily upon the degree of contraction, the Froude number and the normal depth of the unobstructed flow and the geometry of the abutments. Methods of analyzing data include a using energy and momentum principle; dimensional analysis; and empirical correlation.

(h) "Backwater Effects of Bridge Piers and Abutments", by H. K. Liu, J. N. Bradley and E. O. Plate, Colorado State University, Civil Engineering Dept. Report CER57HKL10, October 1957.

(2277) STUDY OF EVAPORATION FROM SOIL SURFACES IN TERMS OF SOIL AND MICROMETEOROLOGICAL FACTORS.

(b) Project of the Western Regional Research Project W-32, "Basic Hydrological Factors Relating to Water Conservation."

(c) Dr. A. T. Corey, Civil Engineering Section, Colorado State University, Fort Collins, Colo.

(d) Experimental and theoretical.

(e) The project is a comprehensive study of moisture transfer from soil by evaporation from the soil surface. The immediate objectives of this investigation are to evaluate the variables known to affect evaporation from soil in order to determine those that are most important in the field, and secondly, to search for relationships among the pertinent variables which will permit quantitative estimates of evaporation from a given soil under prevailing ambient conditions.

(g) It has been found that in the soils studied there is a critical depth of water table. When the water table is above this depth, the rate of evaporation differs slightly from that of a free water surface. At evaporation rates of 1 inch per day or less, the critical depth can be related to moisture release curves obtained on these soils, the critical depth being approximately equal to the air-entry pressure of the soil-water system expressed as a head of water. At very high rates of evaporation the critical depth is substantially less than the air-entry pressure. Theory has been developed to explain these results. It has also been found that with the water table at a specified depth (other than at

the surface) the rate of evaporation increases with radiant energy input until a maximum is reached. Additional increments of radiation decrease the evaporation rates. An attempt is being made to explain this phenomenon.

(h) "Effect of Depth of Water Table on Evaporation from Fine Sand", by Robert W. Staley, Master's Thesis, 1957.
A Doctoral Dissertation is now in preparation by Richard A. Schleusener.

(2278) METHODS OF GENERATING A COMPLEX SEAWAY FOR MODEL STUDIES.

(b) Navy Department through David Taylor Model Basin.

(c) Mr. R. E. Glover, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.

(d) Theoretical investigation of requirements for generating a specified confused sea.

(e) Present model basin wave generators are generally arranged for the production of long-crested waves. These may be regular or irregular in form. It is known, however, that storm seas are, or may be, of short-crested types. The development of means for generating a short-crested confused sea in a model basin is needed to permit model testing under conditions representing storm conditions. It is the objective of this project to develop ways of producing such model seas.

(g) Some wave generator arrangements for producing short-crested seas of simple types have been devised.

(h) "Wave Motion Produced by Linear Wave Generators", by R. E. Glover, Tech. Rpt. No. 1, December 1956.
"First Approximation to a Confused Sea in a Circular Model Basin", by R. E. Glover, Technical Report No. 2, January 1957, Colorado State University, Civil Engineering Dept. Report CER57REG13.
"Brief Note on Mechanical Means of Generating a Confused Sea", by R. E. Glover, Tech. Report No. 3, January 1957, Colorado State University, Civil Engineering Dept. Report CER57REG14.

(2279) LABORATORY AND FIELD STUDY OF THE VORTEX TUBE SAND TRAP.

Cooperative project; Colorado Agricultural Experiment Station and Agricultural Research Service. See U. S. Department of Agriculture, Agricultural Research Service, page 86.

(2510) STUDY OF LOW LEVEL TURBULENCE.

(b) Air Force Cambridge Research Center, Laurence G. Hanscom Field, Bedford, Mass.

(c) Mr. J. E. Cermak, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.

(d) Experimental and theoretical; fundamental.

(e) A wind tunnel having a test section 6- x 6-feet square and 80 feet long with various

arrangements of heating and cooling sur-
faces is being designed and constructed.
An experimental study using the equipment
of project (1566) is being conducted to de-
termine the effect of roughness upon the
characteristics of a turbulent boundary
layer formed over a rough, plane, heated
boundary.

(g) Final phases of the wind tunnel construc-
tion are in progress. Considerable data
on the turbulent boundary layer formed
over a rough, plane, heated boundary has
been obtained using the same experimental
equipment as for Project 1566.

(2511) IRRIGATION WATER APPLICATION AND DRAINAGE
OF LANDS IN THE UPPER COLORADO RIVER BASIN.

(b) Colorado Agricultural Experiment Station
and U.S.D.A.

(c) Mr. N. A. Evans, Civil Engineering Section,
Colorado State University, Fort Collins,
Colo.

(d) Field investigation and experimental;
applied and basic research.

(e) Drainage and reclamation of typical western
valley irrigated lands. Investigational
techniques and procedures for analysis of
groundwater problems are being developed.
The hydraulics of a drainage well system
have been analyzed.

(g) The geophysical technique of electrical
resistivity has been used with excellent
results in stratum investigation. Success-
ful performance of a drainage well has been
found to depend very largely upon openings
in a confining clay stratum. Drainage by
pumping has been found to be economical
under the prevailing conditions.

(2512) MODEL STUDIES FOR BOCONO DAM, VENEZUELA.

(b) Tipton and Kalmbach, Inc., Denver, Colorado.

(c) Dr. A. R. Chamberlain, Chief, Civil Engi-
neering Sec., Colorado State University,
Fort Collins, Colo.

(d) Experimental; applied research.

(e) The purpose of this investigation is to ob-
tain information concerning the action of
water flowing over and through the proposed
dam and appurtenant structures. This in-
cludes: (1) Design and construction of
models in accordance with proposed designs;
(2) qualitative investigation of the flow
characteristics over the spillway and
through the outlet works; (3) calibrating
the spillway and obtaining a rating curve
for discharges released under radial gates
at various openings; (4) a study of a
stilling basin and secondary dam design to
obtain satisfactory energy dissipation, and
check the height of guide walls provided,
and (5) study of the flow pattern and pres-
sure distribution at the ends of the river
outlets opening to the downstream face. A
large scale model will be specially built
for this study, and (6) study the effect
of stilling basin operation on pressure
variations in the draft tubes which dis-
charge into the stilling basin.

(g) A general model has been constructed to a
scale of 1:49.2. The design of the still-
ing basin, secondary dam, and downstream
gravel apron has been finalized, based on
observations of the model performance.
Alterations have also been made in the
crest, piers, and ends of the spillway to
improve flow conditions.

(h) "Interim Report on Model Studies for Bocono
Dam", Colorado State University, Civil En-
gineering Dept. Report CER57ARC28, Oct. 1,
1957. Not available for outside distribu-
tion.

(2513) FLOW MEASURING DEVICES.

(b) Rocky Mountain Forest and Range Experiment
Station.

(c) Dr. A. R. Chamberlain, Chief, Civil Engi-
neering Section, Colorado State University,
Fort Collins, Colo.

(d) Experimental applied.

(e) The purpose of the initial phases was to
test a 1/6 scale model of a modified WSC
flume, to determine its suitability and
calibration curve for applications at flow
measuring stations along steep (5%)
channels of ephemeral streams. The scope
of the research has been expanded to in-
clude a generalized series of tests which
should result in complete design criteria
for trapezoidal open channel flumes.

(g) Experiments completed on the initial phases.
The experiments for the generalized cases
mentioned above have not been completed as
yet.

(h) "Preliminary Model Tests of a Flume for
Measuring Discharge of Steep Ephemeral
Streams", by A. R. Chamberlain prepared
for the Rocky Mountain Forest and Range
Experiment Station, February 1957, Colorado
State University, Civil Engineering Dept.
Report CER57ARC12.

(2514) FUNDAMENTAL INVESTIGATION OF ALLUVIAL
CHANNEL ROUGHNESS.

(b) U. S. Geological Survey.

(c) Mr. D. B. Simons, Civil Engineering Sec.,
Colorado State University, Fort Collins,
Colo.

(d) Experimental; basic.

(e) This study involves a detailed analysis of
the mechanics of bed roughness and sediment
transport in alluvial channels. The first
phase of the investigation deals primarily
with evaluation of resistance to flow in
alluvial channels. This phase of the prob-
lem is currently being studied in a recir-
culating laboratory flume 8 feet wide and
150 feet long. Upon completion of the
laboratory study the results will be modi-
fied by a field study to suit field condi-
tions.

(g) The first sequence of runs in the labora-
tory flume have been completed. A prelimi-
nary report based on the flume data is
currently being prepared.

(h) "Resistance to Flow in Alluvial Channels",
by D. B. Simons and E. V. Richardson,

Progress Report, U.S.G.S., Colorado State University, available in February 1958.

(2516) ANALYTICAL STUDY OF ALLUVIAL CHANNEL ROUGHNESS.

(b) National Science Foundation.
(c) Dr. H. K. Liu, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Analytical; applied research and master's thesis.
(e) A considerable amount of field and experimental data has been gathered from many different sources. An empirical relationship between dimensionless parameters pertinent to the flow and to the sediment has been established. An attempt will be made to confirm the empirical correlation through theory and contribute towards an understanding of the mechanics of ripple formation, of the interaction between flow and sediment in alluvial channels, and to develop design formulas for alluvial channel flow which are valid for a wide range of field conditions, and which show how sediment properties influence the roughness coefficients of the conventional discharge formulas.

(2517) EFFECT OF WASH LOAD ON CONCENTRATION OF BED MATERIAL IN SUSPENSION.

(b) Laboratory project.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.
(d) Experimental; fundamental.
(e) Using a tank with lattice-type agitator to create uniform turbulence, fine sand in the bed of the tank was carried into suspension and measurements made of concentration. A kaolin-type clay was introduced in varying concentrations and the concentration distribution of the suspended bed sand again measured. The temperature was also varied.
(g) Concentrations of 0.5, 1.0 and 2.0 percent of clay were found to increase the average concentration of bed material in suspension by 5.0, 18.0, and 36.0 percent respectively. Although this marked increase in concentration could be attributed in part to the increased viscosity due to the clay, it did not account for all the increase.
(h) "Effect of Wash Load on Suspension of Bed Material Load", by A. Hasan Makarechian, Master's Thesis, November 1956.

(2649) DEVELOPMENT OF DRAINAGE DESIGN CRITERIA FOR IRRIGATED LANDS.

Cooperative project; Colorado Agricultural Experiment Station and Agricultural Research Service. See U. S. Department of Agriculture, Agricultural Research Service, Page 86.

(2760) METEOROLOGICAL OBSERVATIONS.

(b) Colo. Agri. Exp. Sta. and U. S. Weather Bureau.
(c) Mr. M. Parshall, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Field investigation; basic research.
(e) Meteorological observations are made twice daily, as they have been made since 1887. The data serve to determine the climate of this station. The data are used by Experiment Station workers, local companies and private individuals. Evaporation from a free water surface has been measured twice daily during the ice-free season since 1887 and is one of the longest records in the U. S. Elements observed every two hours are: Air temperature, maximum and minimum temperature, wet and dry bulb temperature, terrestrial radiation temperature, soil temperatures at 3, 6, 12, 24, 36, and 72 inches, wind at 15 inches and 65 feet, barometric pressure, precipitation, recording of temperature, pressure and precipitation, sky cover, wind direction and evaporation to 0.001 inch water temperature and maximum and minimum water temperature during ice-free season.
(g) New high and low temperature extremes have been recorded within the past 6 years.
(h) The data from this station are published in part in climatological data for Colo. by the U.S.W.B. There have been in the past Station Bulletins published which carry complete station data as well as standard deviations for some of the data. The last bulletin was published in 1947.

(2761) ECONOMIC EFFECT AND LEGISLATIVE IMPLICATIONS OF GROUND-WATER DEPLETION IN THE LOWER BIJOU BASIN, MORGAN COUNTY, COLO.

(b) Colorado Agricultural Experiment Station and U.S.D.A. Western Regional Project W-42.
(c) Mr. W. E. Code and Mr. I. P. Davis, Colo. State University, Fort Collins, Colo.
(d) Field investigation.
(e) This is a cooperative regional investigation in which 7 states are involved. In Colorado the project is conducted cooperatively between the Economics and Civil Engineering Sections of CSU. Each state will conduct its own study on a particular area where groundwater is being developed. The amount of water pumped from the study area in Bijou Valley was determined for 1956 in conjunction with the effect on the water table. These and other data will be used to determine the life of the supply under present conditions. Conclusions will be drawn on the economic impact on the area under present conditions and what they would have been had some specific type of legislative control been in effect.
(f) Will be completed June 30, 1958.
(g) The water table in Bijou Valley has been receding because of over development since pumping began in 1935. The lowering was very moderate at first but as pumping expanded the rate of lowering was accelerated, particularly since 1948. A groundwater law was passed early in 1957 but there

has not as yet been time for its applications to this area.

(h) A progress report was prepared by Irving P. Davis and W. E. Code and published in Colorado Farm and Home Research, Vol. 7, No. 4, January-February 1957.

(2762) CURRENT METER INVESTIGATION.

(b) U. S. Geological Survey.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Experimental; applied.
(e) To determine the effect on the performance of various types of current meters of: (1) Various intensities and scales of turbulence; (2) proximity of the current meter to a water-air interface; (3) proximity of the bed to the meter; and (4) the orientation of the meter with respect to the flow. The meters being tested are the standard Price and pygmy and several models of a new vane meter which have various numbers and shapes of vanes. The vane meters were designed by Mr. Frazier, U.S. G.S., Columbus, Ohio. The purpose of the new design is to obtain a standard rotar which can be mass produced with sufficient accuracy as to eliminate individual ratings and which will have better characteristics than the Price.

(2763) EQUILIBRIUM CONDITIONS IN OPEN CHANNELS.

(b) National Science Foundation and Colorado State University.
(c) Dr. M. L. Albertson, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Experimental and theoretical; basic research.
(e) The study consists of an analysis of data taken on open channels in both the laboratory and the field. Present emphasis is being placed upon the analysis of profiles of velocity and sediment concentration as associated with secondary circulation.

(2764) OPEN CHANNEL RESEARCH - CONSTRUCTION OF A TILTING FLUME.

(b) National Science Foundation.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Design and construction of equipment.
(e) The above project has as its fundamental purpose the design and construction of basic equipment to be utilized in the CSU investigations in the field of alluvial channel hydraulics.
(g) Design of the flume has been completed. Materials for construction have been received.

(2765) CALIBRATION OF TURBINE METERS FOR THE MARTIN COMPANY, DENVER DIVISION.

(b) The Martin Company, Denver, Colorado.

(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Experimental.
(e) The purpose of the project is to calibrate turbine meters ranging from 3/16" to 12" in nominal size. These turbine meters will later be used for determining flow rates of water, liquid oxygen, liquid nitrogen, RP-1 fuel and MIL-O-5606 hydraulics fluid. Two test stands have been constructed for this purpose.
(g) Calibration curves have been obtained for several meters to date.

(2766) HYDRAULICS OF MEANDERS AND SPUR DIKES.

(b) National Science Foundation.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Theoretical and fundamental.
(e) This project was designed to make use of a certain number of off-campus high school and junior college teachers during the summer of 1957. The faculty members who worked on this project investigated: (a) Utilization of the somascope for measurement of scour around spur dikes; (b) design of a shear transducer for measuring shear along a boundary; (c) mathematical analysis of flow through trapezoidal sections; and (d) theoretical investigation of scour behavior around spur dike configurations.
(h) Final report in progress.

(2767) EDUCATIONAL FILMS ON OPEN CHANNEL FLOW.

(b) U. S. Bureau of Public Roads.
(c) Mr. J. R. Barton, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.
(d) Laboratory and field.
(e) Project involves the making of a color film on open channel flow in connection with highway drainage problems for educational purposes.

(2768) MODEL STUDIES OF THE CUMBAYA PROJECT TUNNEL BY-PASS, ECUADOR.

(b) Tipton and Kalmbach, Inc., Denver, Colo.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Experimental; applied research, design.
(e) This by-pass is needed to carry water around a hydraulic power plant when the power plant is shut down. It operates infrequently. The water passes through an inclined tunnel with a drop of approximately 200 feet. At the outlet end it enters a horizontal tunnel. The problem is to dissipate the energy as it enters the tunnel. A manifold stilling basin forces the water up as a series of jets into the bottom of the tunnel and the energy is dissipated in the overhead water. The problem is to determine the proper size and

number of the jets and the depth of submergence.

(h) "Laboratory Study of a Manifold Stilling Basin", by Gene Fiala, Master's Thesis, May 1957.

(2769) EVALUATION OF FLOWMETERS FOR THE MARTIN COMPANY, DENVER DIVISION.

(b) The Martin Company, Denver, Colorado.
(c) Dr. A. R. Chamberlain, Chief, Civil Engineering Section, Colorado State University, Fort Collins, Colo.
(d) Experimental; applied.
(e) The purpose of the project is to carry out tests on the dynamic, kinematic and general performance characteristics of various types of flowmeters to be inserted in pipelines. The flowmeters to be considered are the Gulton, Gentile Tube, and Maxson Ultrasonic, impact strain gauge, turbine meters and rotameters. The fluids under consideration are water, liquid oxygen, liquid nitrogen, GP-4 fuel, RP-1 fuel and MIL-O-5606 hydraulics fluid.
(g) Preliminary results indicate that the viscosity of the fluid can have a very marked effect on the performance of certain types of turbine meters. Minor variance in interior diameter of the pipelines has a negligible influence on the calibration curve.

(2770) A STUDY OF SHEAR STRESS AT A FLUID-SOLID INTERFACE BY MEASUREMENT OF THE ELECTRO-KINETIC POTENTIAL.

(b) Research Corporation, New York.
(c) Mr. J. E. Cermak, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.
(d) Experimental; basic research.
(e) Electrokinetic potentials developed between wall electrodes at about 1-inch spacing along the length of a 1-inch diameter pipe will be recorded by an oscilloscope camera recorder. Time variation of the electrokinetic potential for laminar, transition and turbulent flow will be studied. These data will be used to obtain fundamental information on boundary shear stress.

(2771) DISTRIBUTION OF A WETTING AND NON-WETTING FLUID PHASE IN A POROUS SOLID.

(b) National Science Foundation.
(c) Dr. A. T. Corey, Civil Engineering Sec., Colorado State University, Fort Collins, Colo.
(d) Experimental; basic research, theoretical.
(e) The purpose of this project is to determine by experimental methods whether or not the distribution of wetting and non-wetting phases in a porous solid depends on the rate at which a wetting phase is displaced by a non-wetting phase. It is planned to obtain this information by measuring the effect of displacement rates on the hydraulic conductivity and on the electrical

conductivity of electrolytes at particular saturations of the wetting phase.
(g) Equipment is being assembled.

(2901) LABORATORY STUDY OF GRAVEL FILTER DESIGN FOR IRRIGATION WELLS.

Cooperative project; Colorado Agricultural Experiment Station and Agricultural Research Service. See U. S. Department of Agriculture, Agricultural Research Service, page 87.

(2902) DEVELOPMENT AND IMPROVEMENT OF WATER MEASURING DEVICES.

Cooperative project; Colorado Agricultural Experiment Station and Agricultural Research Service. See U. S. Department of Agriculture, Agricultural Research Service, page 87.

COLUMBIA UNIVERSITY, Fluid Mechanics Laboratory

(2519) DISPERSION OF DISSOLVED MATERIALS BY FLOW THROUGH GRANULAR MEDIA.

(b) U. S. Geological Survey.
(c) Mr. E. Simpson, Dept. of Geology, Columbia University, New York 27, N. Y.
(d) Experimental and theoretical; doctoral thesis.
(e) Experiments are being conducted to determine the extent of dispersion of dissolved tracer material perpendicular to the direction of flow in a granular media.

(2520) TRANSITIONS FOR SUPERCRITICAL FLOW IN TRAPEZOIDAL CHANNELS.

(b) Laboratory project.
(c) Prof. R. Skalak, Dept. of Civil Engineering Columbia University, New York 27, N. Y.
(d) Experimental and theoretical, master's thesis.
(e) Small scale experiments are used to explore the merit of various transition designs where the initial flow is supercritical in an open trapezoidal channel.
(f) Discontinued.
(g) Tests show that trapezoidal channels carrying supercritical flow may be satisfactorily terminated by converging transitions with vertical walls.
(h) "Transitions for Supercritical Flow in Trapezoidal Channels", F. Wiener, M.S. Thesis, 1957.

(2772) BEHAVIOR OF BUBBLES IN A LIQUID UNDER VIBRATION.

(b) National Science Foundation.
(c) Prof. R. Skalak, Dept. of Civil Engineering Columbia University, New York 27, N. Y.
(d) Experimental and theoretical; basic research.
(e) The formation and migration of air and vapor bubbles in a liquid when a partly

full rigid container is vibrated vertically is being studied experimentally. Surface waves accompanying the vibration are also studied.

(g) Under certain conditions of vibration, bubbles move downward instead of upward as usual.

UNIVERSITY OF CONNECTICUT, Hydraulic Research Laboratory, Department of Civil Engineering.

(1078) HYDROLOGIC FACTORS INFLUENCING RAINFALL-RUNOFF RELATIONSHIPS ON SMALL WATERSHEDS IN EASTERN CONNECTICUT.

(b) Laboratory project; State Highway Dept.
(c) Prof. K. C. Tippy, Box U-37, University of Connecticut, Storrs, Conn.
(d) Field investigation; applied research.
(e) Rainfall and runoff measurements are being taken on small watersheds varying in size from 4 to 400 acres.

(1079) STUDY OF WIND EFFECTS ON STRUCTURES.

(b) Laboratory project.
(c) Prof. A. L. Mirsky, Box U-37, University of Connecticut, Storrs, Conn.
(d) Experimental; applied research.
(e) A study of wind action and flow over various types of buildings and structures is being conducted in a small three-dimensional wind tunnel.

(1080) STUDY OF HYDRAULIC DESIGN OF CURB INLETS.

(b) Laboratory project; State Highway Dept.
(c) Prof. V. E. Scottron, Box U-37, University of Connecticut, Storrs, Conn.
(d) Experimental; for design.
(e) Tests are continuing on the influence of plan form of parallel bar gratings on hydraulic capacity. Field tests are also being conducted.
(g) A report has been issued to the Connecticut Highway Department on the design of parallel bar gratings. A paper covering a portion of this report is published in Annual Report of the Connecticut Society of Civil Engineers, Hartford, Conn., March 1955.

(2073) A STUDY OF SIDE FLOW INTO GUTTERS AND CHANNELS.

(b) Laboratory project.
(c) Prof. V. Scottron, Box U-37, University of Connecticut, Storrs, Conn.
(d) Experimental and analytical.
(e) Work is continuing on the hydraulics of rectangular channels with sloping bottoms and uniformly entering side flow.

CORNELL UNIVERSITY, Dept. of Agricultural Engrg.

(2284) METHODS TO IMPROVE DESIGN AND UTILIZATION OF SPRINKLER IRRIGATION SYSTEMS.

(b) Laboratory project.
(c) Professors H. E. Gray and Gilbert Levine, Project Leaders, Dept. of Agricultural Engineering, Cornell University, Ithaca, New York.
(d) Experimental; applied research.
(e) Continuation of earlier studies of friction loss in commercially available irrigation pipe and couplers. Sizes range from 2 to 6 inch diameters.

CORNELL UNIVERSITY, School of Civil Engineering.

Inquiries concerning Projects Nos. 2285, 2286, and 2775 to 2880, incl., should be addressed to Dr. Andre L. Jorissen, Lincoln Hall, Cornell University, Ithaca, New York.

(2285) QUADRANT EDGE ORIFICE STUDIES.

(b) A. S. M. E. Research Committee on Fluid Meters; laboratory project.
(d) Experimental.
(e) Study of the quadrant edge orifice for discharge measurements at low Reynolds numbers. Reproducibility. Effect of size. Effect of diameter ratio. Influence of pipe roughness.
(f) Inactive.

(2286) EFFECTS OF ROUGHNESS ON VENTURI TUBE COEFFICIENTS.

(b) Builders-Providence, Inc.; laboratory project.
(d) Experimental.
(e) Study of the effects of roughness in the approach pipe and in the converging cone on the coefficient of discharge of Venturi tubes of various characteristics.

(2773) ROLL WAVES AND SLUG FLOWS.

(b) Basic research.
(c) Dr. Paul G. Mayer, School of Civil Engineering, Cornell University, Ithaca, N. Y.
(d) Theoretical and experimental
(e) The cause and subsequent development of intermittent flows in open channels are studied and analyzed. As a result of this investigation, two distinctly different wave train phenomena can be delineated. They are designated respectively as Roll Waves and Slug Flows.
Roll Waves are the result of the interaction of surface tension and gravity forces at a slightly disturbed surface. They form whenever the surface velocity of the stream is less than the minimum velocity of surface waves, provided that the channel slope is sufficiently steep. Roll Waves are characterized by transverse ridges of high vorticity and intermittent quiescent zones.
Slug flows result from instabilities which cause the transition from supercritical laminar flow to turbulent flow. Locally disturbed regions are swept downstream like

travelling oblique hydraulic jumps. They spread transversely and contaminate adjacent zones similar to turbulent spots in wind tunnel studies.

Slug flows form whenever the surface velocity of the undisturbed fluid is in excess of the minimum wave velocity of surface disturbances. They are characterized by a succession of highly agitated surges. The wave crests are separated by turbulent regions.

(g) A theory has been established. The experimental data is analyzed and the pertinent characteristics of Roll Waves and Slug Flows are presented in terms of significant dimensionless parameters. Photographs of significant events are presented and the original data are reproduced.

(h) "A Study of Roll Waves and Slug Flows in Inclined Open Channels", Paul G. Mayer, Ph. D. Thesis, Cornell University, Sept. 1957.

(2774) MODEL STUDY OF DEBRIS DEFLECTOR AT POWER PLANT INTAKE.

(b) American Gas and Electric Service Corp., New York, N. Y.
(c) Prof. Marvin Bogema, School of Engineering, Dept. of Hydraulics and Hydraulic Engineering, Cornell University, Ithaca, N. Y.
(d) Experimental.
(e) A model study of the condenser water intake of the Muskingum River Plant to determine effectiveness of a submerged weir in preventing watersoaked leaves from entering plant intake.

(2775) 20 IN. DALL FLOW TUBE CALIBRATION.

(b) Builders-Providence, Inc.
(d) Experimental.
(e) Calibration and head loss test.
(f) Completed.

(2776) 16 IN. FLOW NOZZLE CALIBRATIONS.

(b) Builders-Providence, Inc.
(d) Experimental.
(e) Calibration of eight 16 in. flow nozzles (4 stainless steel, 4 carbon steel) under conditions of installation with pipe loops and regulating valves in upstream approach pipe.
(f) Completed.

(2777) FLOW NOZZLES AND ORIFICE PLATES CALIBRATION.

(b) Public Service Electric and Gas Company.
(d) Experimental.
(e) Calibration of three 12 inch and four 14 inch flow nozzles, and one 14 inch orifice plate.
(f) Completed.

(2778) 20 IN. ORIFICE PLATE CALIBRATIONS.

(b) Bailey Meter Company.
(d) Experimental.
(e) Calibration.

(2779) VALVE TESTS.

(b) Kennedy Valve Manufacturing Company.
(d) Experimental.
(e) Pressure loss tests on fire hydrants.
(f) Completed.

(2780) 4 IN. NOZZLE CALIBRATION.

(b) Builders-Providence, Inc.
(d) Experimental.
(e) Calibration of test section.
(f) Completed.

UNIVERSITY OF FLORIDA, The Engineering and Industrial Experiment Station, Coastal Engineering Lab.

Inquiries concerning Projects Nos. 2296, 2297, 2298, 2300, 2525, and 2527 should be addressed to Dr. Per Brunn, Coastal Engineering Laboratory, University of Florida, Gainesville, Fla.

(2296) INVESTIGATION OF EXISTING DATA ON TIDAL ENTRANCES.

(b) Beach Erosion Board, Washington, D. C.
(d) Field investigation; basic research.
(e) To analyze existing data on tidal inlets, including estuaries, in order to relate tidal characteristics, tidal prism, inlet area, littoral drift, and pertinent factors to the controlling depth and shoaling tendencies of tidal inlets.
(g) Preliminary report has been made.

(2297) FIELD STUDY OF BEACHES.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) Beach profiles and configurations of shore line on protected and unprotected coasts in Florida are being investigated. The purpose is to obtain data from the Florida shore line. From these data basic information will be derived and they will be used as a basis for practical coastal protection design.

(2298) MODEL STUDY OF DESTRUCTION OF WAVE ENERGY BY VERTICAL WALLS.

(b) National Science Foundation.
(d) Experimental and theoretical; basic research.
(e) The destruction of wave energy by vertical walls will be studied in a wave tank. Different kinds of vertical walls will be investigated.

(2299) MODEL STUDY ON THE BEHAVIOR OF LAKE WORTH.

(b) Port of Palm Beach (Gee and Jensen, Consulting Engineers, West Palm Beach, Fla.).
(c) Mr. F. Gerritsen, Coastal Engineering Laboratory, University of Florida, Gainesville Fla.
(d) Experimental; applied research.
(e) Engineering information will be obtained

on the behavior of Lake Worth, if Lake Worth Inlet will be deepened to accommodate seagoing vessels of greater draft. A hydraulic model of the Lake Worth area has been built to investigate this problem. The model has a solid bottom, and scales of 800 and 40 for the horizontal and vertical dimensions respectively. In the model the behavior of the water table in Lake Worth is investigated when the inlet is deepened to different extents. The tide level in the ocean is used as a boundary condition. The investigation was carried out at normal tide and at storm and hurricane conditions.

(g) Model tests have been completed.

(2300) BEACH EROSION AT FERNANDINA BEACH.

(b) City of Fernandina Beach. Cooperative study with Beach Erosion Board, Washington, D. C.
(d) Field investigation; applied research.

(2525) SEAWALL MODEL STUDY.

(b) Laboratory project.
(d) Experimental and theoretical; basic and applied research.
(e) The absorption of wave energy at different kinds of sea walls will be investigated. Special reference to coastal protection and harbor problems.

(2526) COASTAL ENGINEERING INVESTIGATION AT LONG-BOAT PASS.

(b) Florida State Road Department.
(c) Florida State Road Dept., Tallahassee, Fla.
(d) Field investigation; applied research and design.
(e) The purpose of the investigation is to secure data on the development of Longboat Pass and the adjacent shore lines from which recommendations can be made for proper coastal protection for the bridge connection between Anna Maria and Longboat Key. The research plan involved investigations of changes in the shore line and of beach profiles.
(f) Completed.

(2527) BEACH EROSION INVESTIGATION AT JUPITER ISLAND.

(b) Town of Jupiter Island.
(d) Field investigation; applied research.
(e) The purpose of the investigations is to secure information about the actual situation of the erosion of Jupiter Island and to secure some technical data based upon which recommendations can be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.
(f) The study has been completed and report has been made.
(g) Continuous artificial nourishment of the beach has been recommended.

(h) Results are published in Technical Progress Report No. 5, Vol. XI, No. 3, March 1957, University of Florida.

(2528) COASTAL ENGINEERING STUDY AT THE FREEPORT CAUSEWAY.

(b) Florida State Road Department.
(c) Florida State Road Dept. Tallahassee, Fla.
(d) Field investigation; design.
(e) The purpose of the study is to improve the present design of sea walls used for protection of the causeway; approximately 3 miles of bulkheads of different construction.
(f) The study has been completed and a report has been made.

(2781) COASTAL ENGINEERING STUDY AT DEERFIELD BEACH.

(b) City of Deerfield Beach.
(c) City Manager, Deerfield Beach, Fla.
(d) Field investigation; applied research.
(e) The purpose of the investigations is to secure information about the actual situation of the erosion of Deerfield Beach and to secure some technical data based upon which recommendations can be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.
(f) The field study has been completed.

(2782) COASTAL ENGINEERING STUDY AT BAKER'S HAULOVER.

(d) Dade County Park Department.
(c) Dade County Park Dept., Miami, Fla.
(d) Field investigation; applied research.
(e) The purpose of the investigations is to secure information about the actual situation of the erosion of Baker's Haulover and to secure some technical data based upon which recommendations can be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.
(f) Field study has been completed.

(2783) COASTAL ENGINEERING STUDY AT FT. PIERCE BEACH.

(b) Ft. Pierce Beach Erosion District.
(c) Ft. Pierce Beach Erosion District, Fort Pierce, Florida.
(d) Field investigation; applied research.
(e) The purpose of the investigations is to secure information about the actual situation of the erosion of Ft. Pierce Beach and to secure some technical data based upon which recommendations can be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.

(2784) COASTAL ENGINEERING STUDY AT CAPTIVA ISLAND.

(b) Lee County.
(c) Board of County Commissioners, Lee County, Ft. Myers, Florida.
(d) Field investigation; applied research.
(e) The purpose of the investigations is to secure information about the actual situation of the erosion of Captiva Island and to secure some technical data based upon which recommendations can be made for immediate relief of the acute erosion problem. The plan of research involved investigations of changes in the shore line and beach profiles.
(g) The field study has been completed and a preliminary report has been made.

GEORGIA INSTITUTE OF TECHNOLOGY, Hydraulics Laboratory.

Inquiries concerning Projects Nos. 291, 1584, 1852, 1854, 1855, 2529, and 2785, should be addressed to Prof. C. E. Kindsvater, School of Civil Engineering, Georgia Institute of Technology, Atlanta, Ga.

(291) FLOW OF WATER OVER HIGHWAY EMBANKMENTS.

(b) Laboratory project.
(d) Experimental; research for master's thesis (S. P. Prawel).
(e) Experimental data are being obtained on the discharge characteristics of an embankment-shaped weir. Emphasis has been placed on free discharge over smooth-surfaced embankments. Data have been obtained on the influence of embankment height and tailwater submergence. Detailed velocity surveys have been made to define the boundary layer between the upstream edge of the upstream shoulder and the crown. Tests are being made on a 1:9-scale model in a 3-foot wide flume.
(g) It has been established that the discharge characteristics of an embankment can be related to the theoretical equation of discharge for a broad-crested weir by means of the discharge-displacement boundary-layer thickness. Data and procedures for computing the thickness of the boundary-layer at the control section are being sought as a means of generalizing the discharge equation for various shapes, sizes, and roughnesses of embankments.

(1331) THE DIFFUSION OF FOREIGN PARTICLES IN A FLUID.

(b) Laboratory project; sponsored by the National Science Foundation.
(c) Dr. M. R. Carstens, School of Civil Engineering, Georgia Institute of Technology, Atlanta, Georgia.
(d) Experimental; basic research for doctoral dissertation.
(e) The diffusion of macroscopic foreign particles is to be studied in a vertical diffusion chamber. The turbulence pattern is to be repetitive in the vertical direction and is to be controlled both in

amplitude and frequency. The purpose of the study is to determine the difference in diffusion characteristics of the foreign particles and the fluid.
(g) Experimental equipment has been constructed

(1584) FLOW OF WATER OVER WEIRS AND SPILLWAYS.

(b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
(d) Library search, re-analysis and correlation of published data, plus original research as required.
(e) A comprehensive study of the discharge characteristics of practical forms of weirs and spillways. Initial phase includes the preparation of bibliography and the collection of experimental data from all known sources. Objectives include the publication, in generalized form, of available experimental data.

(1852) DISCHARGE CHARACTERISTICS OF RECTANGULAR PLATE WEIRS IN RECTANGULAR CHANNELS.

(b) Laboratory project; partly sponsored by the U. S. Geological Survey.
(d) Experimental and analytical; research for two master's theses.
(e) An investigation of the comprehensive discharge characteristics of the basic sharp-edged, rectangular-notch weir. An attempt to evaluate by experimental means the influence of the several variables excluded by restrictions on the standard weir formulas. Tests cover a full range of notch widths, weir heights, and heads. Investigation limited to free flows of water at normal temperatures.
(f) Completed.
(h) "Discharge Characteristics of Rectangular, Thin-Plate Weirs", by Carl E. Kindsvater and Rolland W. Carter, Proceedings, ASCE, (publication pending).

(1854) INFLUENCE OF BOUNDARY ROUGHNESS ON ABRUPT ENLARGEMENTS IN ENCLOSED CONDUITS.

(b) Laboratory project.
(d) Experimental; research for two master's theses.
(e) An experimental investigation of the influence of boundary roughness on the total energy loss due to abrupt area-enlargements in circular conduits. Variables include discharge, expansion ratio and roughness.
(h) Master's thesis completed by B. J. Kittle, 1957.

(1855) TRANQUIL FLOW THROUGH SEVERAL OPENINGS IN AN OPEN-CHANNEL WIDTH CONSTRICTION.

(b) Water Resources Division, Surface Water Branch, U. S. Geological Survey.
(d) Experimental; basic research.
(e) Objective is to establish principles of flow division at a multi-opening width constriction. A 14-foot wide by 80-foot long flume is being used in the experimental investigation. Channel shape,

degree and pattern of boundary roughness
and constriction geometries will be varied.
Boundary conditions considered will be
governed by highway bridge practice.

(2529) UNIFORM FLOW IN OPEN CHANNELS.

(b) Water Resources Division, Surface Water
Branch, U. S. Geological Survey.
(d) Re-analysis and correlation of existing
data; original experimental research and
analysis.
(e) A fundamental investigation of the mechanics
of uniform flow in open channels, with em-
phasis on the influence of channel shape
and non-uniform roughness patterns. Experi-
mental work is being conducted in a 90-foot
long flume, 18 inches deep and 3.5 feet
wide.

(2785) APPLICATION OF THE ELECTRONIC COMPUTER FOR
THE DIRECT SOLUTION OF THE FLOW EQUATIONS
OF A DISTRIBUTION SYSTEM.

(b) Laboratory project.
(c) Dr. M. R. Carstens, School of Civil Engi-
neers, Georgia Institute of Technology.
(d) Analytical; research for master's thesis.
(e) The energy and continuity equations of
flow in a network of pipes are solved by
means of an electronic computer. The equa-
tions containing the quadratic terms
(energy equations) are replaced by a system
of linear equations with variable coeffi-
cients. The resulting system of linear
equations can be solved by means of stand-
ard programs for the electronic computer.
Illustrative problems solved in this manner
include (a) network with constant inflow
and constant outflow, (b) network contain-
ing elevated reservoirs with constant out-
flow from the network, (c) network con-
taining elevated reservoirs with a variable
outflow from the network which depends on
the pressure at the outflow point, and (d)
network containing elevated reservoirs with
a constant outflow from the network, but
with a variable inflow to the network de-
pending upon the pump characteristics.

UNIVERSITY OF HOUSTON, Dept. of Chemical Engineering.

(2303) ENTRAINMENT IN TWO-PHASE GAS-LIQUID FLOW.

(b) Laboratory project.
(c) Prof. A. E. Dukler, Chemical Engineering
Dept., University of Houston, Houston, Tex.
(d) Experimental, theoretical, basic research,
master's thesis.
(e) A study of the entrainment of liquid into
the gas phase for the concurrent annular
flow configuration. Measurements are made
of entrainment distribution for horizontal
flow in various tube sizes, flow rates and
fluid properties. Purpose of the work is
to develop and test the relationships to
(1) Relate rate of entrainment to the ex-
ternal variables, and (2) evaluate drop

size distribution of entrained liquid.
(g) Data have been obtained for one- and three-
inch tubes over a wide range of flow rates
for water and air. Both the absolute en-
trainment and its distribution along a
radius depends on the energy loss in the
entrance section. Data are now being
analyzed.

UNIVERSITY OF IDAHO, Engineering Experiment Station.

Inquiries concerning Projects Nos. 1859 and 2080
should be addressed to Prof. C. C. Warnick, Asso-
ciate Director, College of Engineering, and Projects
Nos. 1861, 1862, 2081, 2304, and 2786 should be
addressed to Prof. G. L. Corey, Dept. of Agricul-
tural Engineering, University of Idaho, Moscow,
Idaho.

(1859) A STUDY OF EFFECTIVENESS OF CANAL LININGS
AND SOIL SEDIMENTS IN CONTROLLING SEEPAGE
LOSSES.

(b) Laboratory project; cooperative with U. S.
Bureau of Reclamation.
(d) Field investigation; basic and operational
research.
(e) Different types of canal linings are being
studied and various ways of evaluating per-
formance are being considered especially
ideas for measuring canal seepage from both
lined and unlined canals.
(g) Five years of field work have been completed
on seepage loss characteristics and per-
formance of experimental canal linings.
(h) Progress report being prepared for limited
distribution.

(1861) THE IMPROVEMENT AND DEVELOPMENT OF STREAM-
FLOW MEASURING DEVICES.

(b) Laboratory project; cooperative with
Agricultural Research Service, being
carried on under the Agricultural Experi-
ment Station.
(d) Experimental; applied.
(e) Study is being made, in laboratory and in
field streams with full-size models, of the
hydraulic characteristics of crest gages
under controlled conditions. A direct
reading current meter of new design is being
developed for convenient field use.
(g) Several crest gages have been evaluated and
an improved design developed. This has
been studied in a fluid polariscope to es-
tablish flow characteristics. The new
current meter has been calibrated and used
experimentally.

(1862) DETERMINATION OF ANNUAL RUNOFF FROM WATER-
SHED CHARACTERISTICS.

(b) Laboratory project, being carried on under
Agricultural Experiment Station.
(d) Experimental; applied research.
(e) A statistical study has been started on
correlation between various watershed
characteristics and annual runoff on gage

watersheds for eventual application to un-
gaged areas. This work is being continued
by V. I. Myers who is now with the Agricul-
tural Research Service. An additional
phase is a detailed study of the hydrologi-
cal factors affecting the Moscow Mountain
Watershed as it applies to the total water
use in the area.

(g) The latter study has just been started and
stream gaging information is being obtained
and processed.

(h) A paper on the first phase is being pre-
pared by Mr. Myers.

(2080) A STUDY OF RIME ICE AND SNOW CAPPING ON
HIGH ALTITUDE PRECIPITATION GAGES.

(b) Laboratory project; in cooperation with U.
S. Weather Bureau, Bureau of Reclamation,
Corps of Engineers, Soil Conservation
Service and City of Moscow.

(d) Field investigation; basic and applied
operational research.

(e) Several experimental gages have been in-
stalled to obtain basic data on snow
capping. An electrical means of heating
the orifice of the gage is being studied.

(g) Field gages have been in operation for two
years and new special heated-orifice gages
have been placed in operation. Several
pieces of weather measuring equipment have
been incorporated into the project the past
year.

(h) "Rime Ice and Snow Capping on High Altitude
Precipitation Gages", C. C. Warnick, Pro-
ceedings of the Western Snow Conference,
Santa Barbara, Calif., April 17-19, 1957.

(2081) THE DESIGN AND EVALUATION OF SPRINKLER
IRRIGATION SYSTEMS.

(b) Cooperative with Agricultural Research
Service under the Agricultural Engineering
Department.

(d) To evaluate the engineering design of
existing sprinklers, obtain field data re-
lated to design and operation of systems
and to establish sprinkler design criteria
for Idaho conditions.

(g) Several evaluations have been completed
and data are being assembled.

(2304) MECHANICS OF WATER CONTROL ON STEEP IRRI-
GATED LAND.

(b) Laboratory project; under investigation in
Agricultural Experiment Station.

(d) Field investigation; applied research for
master's thesis.

(e) To test the characteristics and effective-
ness of water control structures and de-
vices used on farms. To evaluate the re-
sistance to erosion of irrigated soils.
To develop improved devices and techniques
for control of erosion and to increase
efficiency in application of water.

(g) Several water control devices were tested
both in the laboratory and in the field.
Several techniques for measuring erosion
were developed.

(h) A final publication is being prepared.

(2786) FARM IRRIGATION EFFICIENCIES.

(b) Laboratory project; cooperatively with
Bureau of Reclamation under the Agricul-
tural Experiment Station.

(d) Field investigation; basic and applied re-
search.

(e) To evaluate irrigation efficiencies on
actual farms to aid in planning of a water
use on irrigation projects. To consider
efficiency from aspect of farm operations
and not just consumptive use of crops.

(g) Project is just being activated by C. Tyler
in a new irrigation tract near Rupert,
Idaho, called the Northside Pumping Divi-
sion of the Minidoka Project.

ILLINOIS STATE WATER SURVEY DIVISION, Urbana.

Inquiries concerning Projects Nos. 556-560, 845,
1335, 1866, 2314, 2315, and 2535 should be addressed
to Mr. William C. Ackermann, Chief, Illinois State
Water Survey, Box 232, Urbana, Illinois.

(551) RUNOFF FROM SMALL WATERSHEDS.

(b) Laboratory project, cooperative with U. S.
Geological Survey.

(c) Mr. W. J. Roberts, Illinois State Water
Survey, Box 232, Urbana, Ill.

(d) Field investigation; applied research,
design.

(e) Measurements of watershed rainfall and
streamflow, of stage-discharge over the
spillway, and municipal pumpage; reduced
from five to two water-supply reservoirs
in central Illinois. Collection of data
at the three southern Illinois reservoirs
complete and terminated.

(h) Data to 1946 published as Water Survey
Bull. 38. Annual summaries 1946 to 1956
for all five reservoirs and summaries for
two central Illinois reservoirs for 1956-57
water year available for distribution.

(552) SEDIMENTATION OF ILLINOIS RESERVOIRS.

(b) Laboratory project, cooperative with
Agricultural Research Service, Soil Conser-
vation Service, University of Illinois
Agricultural Experiment Station.

(c) Mr. J. B. Stall, Illinois State Water Survey
Box 232, Urbana, Illinois.

(d) Field investigation; applied research.

(e) For design of water-supply reservoirs,
measurements of sediment accumulation on
lakes in Illinois. Sediment samples are
analyzed and complete surveys of watershed
soil type, slopes, land use, and conserva-
tion practices are made.

(g) Results of Lake Decatur, Illinois, showed
correlation between rate of sedimentation
and land use on watershed.

(h) Reports of Investigation Nos. 4, 7, 8, 9,
10, 12, 15, 16, and 18; sedimentation sur-
veys of Spring Lake, Ridge Lake, Lake

Chautauqua, Carbondale Reservoir, Lake
Bracken, West Frankfort Reservoir, Lake
Calhoun, Lake Springfield, and Lake
Carthage, respectively.

(553) RADAR-RAINFALL PROJECT.

(b) Laboratory project, cooperative with Signal
     Corps Engineering Labs.
(c) Mr. G. E. Stout, Illinois State Water Sur-
     vey, Box 232, Urbana, Illinois.
(d) Field investigation; basic research.
(e) Radar is being used to determine precipita-
     tion quantitatively. Emphasis is being
     concentrated on the measurement of rain-
     drop size distribution at Miami, Fla.; Cor-
     vallis, Ore., and Champaign, Ill., to de-
     termine climatic variation of drop size.
(g) Data being collected.
(h) Reports of Investigation 13, 19, 21, 27,
     29 and Circular 49 of Water Survey; Prog-
     ress report to Signal Corps.

(555) EVAPORATION IN ILLINOIS.

(b) Laboratory project.
(c) Mr. W. J. Roberts, Illinois State Water
     Survey, Box 232, Urbana, Illinois.
(d) Field investigation; applied research.
(e) Measurements are made of evaporation at
     four stations in northern, central, and
     southern Illinois. Vapor pressure gradi-
     ents are obtained at Urbana. Evaporimeters
     constructed and installed adjacent to pans
     for year-round records.
(h) Measurements published in Climatological
     Data, Illinois Section.

(556) PERMEABILITY OF GRADED SAND MIXTURES.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Permeabilities of known mixtures of graded
     sand are measured to determine functional
     changes.
(g) Sand mixtures containing 60 to 70 percent
     of fine material in 40 to 30 percent of
     coarser from 2 adjoining sieves of the $\sqrt{2}$
     series have less permeability than the
     material of the fine screen alone. Evidence
     accumulates that the permeability is not
     much influenced by the amount of voids but
     greatly by the size of the smallest opening
     between sand grains.

(557) TURBULENT FLOW THROUGH GRANULAR MEDIA.

(b) Laboratory project.
(d) Experimental; basic research.
(e) Critical flow is determined to define con-
     ditions under which turbulent flow occurs
     outside well screens.
(g) In flow through granular media, the Reynolds
     number cannot be calculated from ordinary
     formulas. By assuming a critical Reynolds
     number as existing at the determined criti-
     cal flow conditions, the corresponding pore
     size can be calculated. This has been done
     in preliminary tests, but further work is
     needed to obtain a correlation with screen

analysis.

(558) STUDY OF CAUSES AND PREVENTION OF SAND BOILS

(b) Laboratory project.
(d) Field investigation; basic research.
(e) Sand boils occurring during floods in levied
     districts are mapped, classified, and
     sampled. Also sampled are river and near-
     by well waters.
(g) From chemical analyses and temperature
     measurements, it was found that the water
     flowing in typical sand boils (those free
     from pipe connections towards the river) is
     different from the river water and similar
     to well water in neighboring wells. Such
     sand boils can be stopped from flowing by
     damming them up to a level that is below
     that of the river stage. They are not
     caused by leaks through the levee.

(559) ARTIFICIAL RECHARGE OF GROUND WATER.

(b) Laboratory project.
(d) Experimental laboratory and field investi-
     gation; basic research.
(e) Experimental pilot plant consists of river
     intake, control tower with chlorination
     and measuring devices, gravel pit with
     bottom 10 feet below river pool stage,
     sides and bottom covered with pea gravel.
     A model of 1/8 of pit (centerline to diag-
     onal) is available to study different types
     of pits and variations in ground water
     gradients. A second pit has been built and
     operated with a 20 ft x 75 ft bottom and
     1:3 slopes. The first pit has 40 ft x 62.5
     ft bottom and 1:2 slopes.
(g) Pit in operation for seventh winter. Seven
     months of uninterrupted operation gave
     silting in only top 2 inches of 6-inch
     layer of pea gravel. The pea gravel gave
     satisfactory filtration and nearly tripled
     the inflow compared with using sand to give
     a rate of inflow of from 20 to 25 million
     gallons per day per acre. The second pit
     gave operating rates double those of the
     first pit.
(h) Mimeographed reports for each of first 6
     seasons have been issued.
     "Water Survey Circ. 54", Proc. ASCE, Jour.
     Irrig., Nov. 1956, Paper 1102.

(560) GROUND WATER INVESTIGATION IN THE PEORIA,
       ILLINOIS, DISTRICT.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) To determine the ground water resources of
     the district, inventory of wells made, in-
     cluding construction and logs of wells.
     Ground water levels are measured continu-
     ously, pumpage data collected, river stages
     and rainfall recorded, chemical analyses
     for changes in composition of ground water
     are made, areas of infiltration are deter-
     mined, and all data are correlated with
     consideration of local ground conditions.
(g) To date conservation measures have shown
     more effect than artificial recharge.

(561) GROUND WATER INVESTIGATION IN EAST ST. LOUIS AREA.

   (b) Laboratory project.
   (c) Mr. Otis E. Michels, Illinois State Water Survey, Box 232, Urbana, Ill.
   (d) Field investigation; applied research.
   (e) To evaluate the ground water resources of American Bottoms (E. St. Louis region). Ground water levels are measured continuously. Pumpage, river stage, and rainfall data are collected; chemical quality of ground water is measured. Areas of infiltration are to be determined and all data correlated with consideration of local conditions. Statistical studies have been made of the service lives of municipal wells.

(843) GROUND WATER RESOURCES IN JO DAVIESS, STEPHENSON, AND CARROLL COUNTIES.

   (b) Laboratory project.
   (c) Mr. H. F. Smith, Illinois State Water Survey, Box 232, Urbana, Illinois.
   (d) Field investigation; applied research.
   (e) To determine ground water resources of area, water level contours of sandstone aquifers, transmissibility and storage coefficients of aquifers, and quantity of water available were obtained.
   (f) Suspended.
   (g) Data indicate piezometric surface conforms generally with topography, with a 500-foot drop in about 30 miles with no apparent withdrawal. Sandstone aquifers overlain by 100 to 300 feet and more of impervious limestone.

(845) EXTENSION OF THEIS' NON-EQUILIBRIUM THEORY FOR VARIABLE FLOW.

   (b) Office project.
   (d) Theoretical; basic research.
   (e) Development of formulas that could be used for conditions of variable flow.
   (g) Formulas developed for most important types of variable flow, but series obtained have not been calculated for wide ranges.

(1092) HYDROLOGIC CYCLE EVALUATION.

   (b) Laboratory project; cooperative with U. S. Geological Survey.
   (c) Mr. H. F. Smith, Illinois State Water Survey, Box 232, Urbana, Ill.
   (d) Field investigation; applied research.
   (e) Data from rain gage networks (gathered under Project 553) together with information from 5 stream gaging stations and 5 ground water level recorders are being maintained. Data will be used in analyzing storm rainfall-runoff relationships on small watersheds and effect of runoff on water table. Analysis in progress.

(1335) GROUND WATER INVESTIGATION IN THE CHICAGO AREA.

   (b) Laboratory project.

   (d) Field study on variations of natural resources. Investigation of artesian well field with wells 1200 to 2200 feet deep, locally heavily pumped. Study of ground water level recession, interferences, transmissibilities, effect of additional demands.
   (g) Results determine recession and give good data for future prediction. Collection of data continued.

(1341) CORROSION STUDY.

   (b) Laboratory project.
   (c) Dr. T. E. Larson, Illinois State Water Survey, Box 232, Urbana, Ill.
   (d) Experimental.
   (e) Basic study of corrosion occurring at the steel electrodes under flow through a 26-foot plastic tower.
   (f) Delayed; lack of personnel.
   (g) Apparatus is being adjusted.

(1342) STUDY OF CORROSION AND DEPOSITION RATES WITH DIFFERENT FLOW RATES.

   (b) Laboratory project.
   (c) Dr. T. E. Larson, Illinois State Water Survey, Box 232, Urbana, Ill.
   (d) Experimental.
   (e) One-half inch pipes of different materials are in service. Changes in flow due to corrosion and at constant head are being measured.
   (f) Abandoned; lack of personnel.

(1865) HYDRAULIC DESIGN OF DROP-INLET SPILLWAY STRUCTURES FOR SMALL RESERVOIRS.

   (b) Laboratory project, in cooperation with Agricultural Research Service, Soil Conservation Service, and University of Illinois Agricultural Experiment Station.
   (c) Mr. H. W. Humphreys, Illinois State Water Survey, Box 232, Urbana, Ill.
   (d) Experimental; generalized applied research for development and design.
   (e) To determine the most desirable proportions and shapes of drop-inlet spillway structures that have unique flow characteristics and to develop anti-vortex devices. To provide the necessary information on flow relations and discharge coefficients so that these structures may be economically designed. Initial phases of study concerned with hydraulics of square risers with free discharge. Effect of lip or crest shape and anti-vortex devices being studied. Second phase to include the complete spillway.
   (f) New experimental apparatus being assembled to test complete spillway.
   (g) Hydraulics of various types of flow possible in square risers are well defined as well as some of effects of non-square crest shape.

(1866) GROUND WATER FORMULAS.

   (b) Office project.

(d) Theoretical.
(e) Compilation of all published ground water theories and formulas and a comparative evaluation of their range of usefulness.
(h) Report in preparation.

(2311) A METHOD OF DETERMINING PERMEABILITY AND WELL YIELD FROM THE EFFECTIVE GRAIN SIZE.

(b) Laboratory project.
(c) Mr. H. F. Smith, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Field data; applied research.
(e) Study to determine relationships between effective grain size and permeability and between coefficient of transmissibility and specific capacity.
(f) Completed.
(g) Curves established to illustrate relationships.
(h) State Water Survey Circular 59.

(2313) GROUND WATER INVESTIGATION AT CRYSTAL LAKE, ILLINOIS.

(b) Laboratory project.
(c) Mr. R. T. Sasman, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Field investigation; applied research.
(e) To study correlation of lake levels and ground water levels in vicinity of Crystal Lake, McHenry County.
(f) Completed.
(h) Report of Investigation 32.

(2314) ELECTRICAL ANALOGUE OF CHICAGO GROUND WATER CONDITIONS.

(b) Laboratory project.
(d) Experimental; applied research.
(e) Tap water about 2 inches deep is held on a paraffin base. The boundary of the depression cone is given by a metal band. Wells or well groups are marked geographically by metal rods. These are charged by electrical voltage in proportion to existing or planned pumpage. A separate probe measures the location of equal potential lines which correspond to equal heights of ground water levels. Variations in permeability are represented by variations in water depth and determined by comparison with the actual ground water levels as found in observation wells.

(2315) INTERFERENCE BETWEEN RECHARGE PITS.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) A recharge pit is being built about 200 feet from the pit mentioned in project 559 and the mutual influence of the two pits is studied by a series of observation wells between the pits.
(g) Pit in operation. To date no interference has been detected.

(2532) EVAPORATION RETARDATION.

(b) Laboratory project.

(c) Mr. W. J. Roberts, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Field investigation; applied research, design.
(e) Experiments with monomolecular chemical films to retard evaporation from a 3-acre pond and a 230-acre lake in Illinois. Laboratory studies continuing on smaller containers.
(g) Analysis in progress
(h) "Evaporation Suppression from Water Surfaces", by W. J. Roberts, Trans. AGU, Oct. 1957.

(2533) MOISTURE INFLOW STUDY.

(b) Laboratory project.
(c) Mr. R. G. Semonin, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Theoretical; applied research.
(e) Computation of moisture inflow of Illinois and subsequent correlation with precipitation. Moisture and wind data obtained from ROAB data.

(2534) DENSE RAIN GAGE NETWORK PROJECTS.

(b) Field and laboratory project.
(c) Mr. F. A. Huff, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Field investigation; applied research.
(e) Data from four rain gage networks, consisting of 50 gages in 400 square miles, 10 gages in 100 square miles, 40 gages in 400 square miles, and 10 gages in 8 square miles. Obtained to study: (1) Rainfall variability, (2) frequency of point and areal mean rainfall rates, (3) area-depth relations, (4) variation of point rainfall with distance, (5) areal representativeness of point rainfall, and (6) reliability of areal mean rainfall estimates.
(f) Static; awaiting new data.
(h) Water Survey Bull. 44, "Rainfall Relations on Small Areas in Illinois."

(2535) FILTERING THROUGH COARSE MATERIAL.

(b) Laboratory project.
(d) Various sizes of rounded gravel and of broken limestone have been put in tile rings into bottom of recharge pit to determine limit in coarseness of filter material.
(g) Filtering occurs through material up to 3/4-inch size.

(2787) PRECIPITATION FREQUENCY.

(b) Laboratory project.
(c) Mr. F. A. Huff, Illinois State Water Survey, Box 232, Urbana, Ill.
(d) Applied research.
(e) Recurrence intervals of heavy precipitation in periods of 1 to 10 days duration are being determined on an annual and seasonal basis for Illinois, using data from 39 stations for a 40-year period. Average relations with definition of their reliability are being calculated for sections

of similar storm climate. Several statis-
tical approaches used for frequency analy-
sis are being evaluated.
  (f) Analysis nearing completion.·

(2788) METEOROLOGY OF FLOOD-PRODUCING STORMS.

  (b) Laboratory project.
  (c) Mr. R. G. Semonin, Illinois State Water
       Survey, Box 232, Urbana, Illinois.
  (d) Theoretical and applied research.
  (e) Investigation of meteorological conditions
       associated with flood-producing storms in
       Illinois to obtain basic data for reliable
       definition of time and space distribution
       and calculation of probable maximum rain-
       fall.

ILLINOIS STATE WATERWAYS DIVISION, Springfield.

(1863) EROSION CONTROL, ILLINOIS SHORE OF LAKE
        MICHIGAN.

  (b) State of Illinois.
  (c) Mr. Thomas B. Casey, Chief Waterway Engi-
       neer, Division of Waterways, Dept. of
       Public Works and Buildings, 201 W. Monroe
       Street, Springfield, Illinois.
  (d) Field investigation; applied research.
  (e) To obtain and correlate basic data on the
       several forces and factors involved in
       erosion processes along the Illinois Shore
       of Lake Michigan to the end that future
       efforts toward the prevention of erosion
       might be founded upon a more definite and
       factual basis with a consequent greater
       degree of assurance that the works will
       serve the intended purposes.

UNIVERSITY OF ILLINOIS, Soil and Water Conserva-
tion Engineering Laboratory, Department of Agri-
cultural Engineering.

Inquiries concerning Projects Nos. 2316, 2317, and
2789 should be addressed to Prof. R. C. Hay, 100
Agricultural Engineering, University of Illinois,
Urbana, Illinois.

(2316) RUNOFF FROM SMALL AGRICULTURAL AREAS IN
        ILLINOIS.

  (b) Laboratory project cooperative with ARS,
       USDA.
  (d) Experimental and field investigation;
       basic research.
  (e) To determine frequencies of peak rates
       and total amounts of runoff from agricul-
       tural watersheds of 25 to 1,000 acres; to
       determine maximum rates of runoff from
       agricultural watersheds in different soil
       association areas in Illinois; to compare
       runoff from agricultural watersheds under
       accepted soil conservation practices with
       watersheds cultivated without soil conser-
       vation practices. Watersheds of 45.5, 63,
       82, and 390 acres near Monticello, Ill.

are covered with a rain gage network, and
runoff is measured at weirs and spillway
structures by water level recorders. Maxi-
mum stage recorders are installed at field
structures on 25 watersheds in Champaign,
Piatt, Vermillion, and Ford Counties on
watersheds ranging in size from 45 to 1,400
acres. Model studies and field calibra-
tions are made on the field structures.
  (g) Research bulletin covering first eight
       years of results under preparation.

(2317) A STUDY OF DRAINAGE OF SOME ILLINOIS SOILS.

  (b) Laboratory project cooperative with ARS,
       USDA.
  (d) Field investigation; applied research.
  (e) To determine on different soil types the
       effect of tile spacing and depth on (1)
       water table as measured by drawdown wells,
       (2) on crop yields; to verify present tile
       depth and spacing formulas for soil types
       investigated; and to compare physical
       laboratory measurements with field measure-
       ments.
       The rate of water table drawdown is
       measured in wells perpendicular to tile
       lines. Field permeability and laboratory
       permeability measurements are made as well
       as physical analysis of the soil type.
       Crop yields are determined laterally from
       the tile lines.

(2789) LABORATORY MODEL STUDIES OF CONSERVATION
        AND DRAINAGE STRUCTURES.

  (b) Laboratory project.
  (d) Experimental investigation in the labora-
       tory; applied and basic research.
  (e) To investigate the performance of soil and
       water conservation structures by means of
       hydraulic model studies, to study water
       flow patterns into surface drains and to
       determine the cause of failures and re-
       medial measures of certain conservation
       structures under flood conditions. This
       project is to be carried out in connec-
       tion with Projects 2316 and 2317. It has
       been initiated as a separate project in
       1957.

UNIVERSITY OF ILLINOIS, Department of Civil Engi-
neering.

Inquiries concerning Projects Nos. 1097, 1589,
2085 to 2088, incl., 2318, and 2790, should be
addressed to Prof. J. C. Guillou, Civil Engineering
Dept., University of Illinois, Urbana, Illinois.

(564) HYDROLOGY OF URBAN AREAS.

  (b) Laboratory project, cooperative with
       Illinois State Water Survey.
  (c) Prof. J. J. Doland and V. T. Chow, Uni-
       versity of Illinois, Urbana, Illinois.
  (d) Experimental, theoretical, and field in-
       vestigation; applied research and design.
  (e) Rainfall-runoff study of an urban watershed,

having an effective drainage area of 4.45 square miles and a population density of 14 persons per acre. Runoff is measured by a U.S.G.S. stream gage and precipitation by a network of fourteen rain gages strategically located in and out of the watershed. New type of evaporimeter have been developed and check studies are being made.

(h) "Hydrologic Studies of Urban Watersheds, Rainfall and Runoff of Boneyard Creek Champaign-Urbana, Illinois", by Ven Te Chow, Civil Engineering Studies, Hydraulic Engineering Series No. 2.

(1097) CORRECTION OF SCOUR BELOW TWO PIER HIGHWAY BRIDGE.

(b) Laboratory project, in cooperation with Illinois Division of Highways.
(d) Experimental; applied research.
(e) A 1:50 scale model of an overflow bridge on flood plain of the Wabash River has been constructed as an aid in determining the cause of excessive scour just downstream from the bridge. Remedial dikes a and topography changes have been tested in the model to determine their suitability.
(f) Completed.
(h) "Hydraulic Studies of a Highway Bridge", by Irby J. Hickenlooper, John C. Guillou, and Ven Te Chow, Civil Engineering Study, Hydraulic Engineering Series No. 4, June 1957.

(1589) OPEN CHANNEL METER.

(b) Laboratory project in cooperation with Theoretical and Applied Mechanics Dept.
(d) Experimental and analytical.
(e) This study is concerned with a critical depth meter which may be economically built in a sewer after the sewer has been in service. Preliminary tests and analyses have been completed. Tests are underway using a 16-inch diameter pipe, with adjustable slope, and lucite test section. Laboratory results agree favorably with theoretical indications.

(1591) DETERMINATION OF WATERWAY AREAS.

(b) Laboratory project, cooperative with Illinois Division of Highways.
(c) Prof. J. J. Doland and V. T. Chow, University of Illinois, Urbana, Illinois.
(d) Analytical and field investigation; applied research and design.
(e) To determine the amount of water which will reach openings of highway drainage structures, such as bridges and culverts and provide a simple but scientific procedure for use of engineers in establishing the economical and adequate size of opening.
(g) Five preliminary reports and two field reports have been prepared. The field reports are "Preliminary Report of the Study of Culverts at Petersburg, Ill." and "Preliminary Report of the Study of Channel

Relocation and Culvert Problem at Florence, Illinois." The preliminary reports are: "A Compilation of Formulas for Waterway Area Determination", "A Historical Review of Engineering Studies of Waterway Area Determination", "Annotated Bibliography of Waterway Area Determination", "A Survey of the Current Practice of Waterway Area Determination Employed by Different State Highway Agencies in The United States", and "The Development of a Tentative Procedure for the Determination of Waterway Areas."

(h) Publications are not yet available to the public.

(2085) CALIBRATION AND USE OF CERTAIN INLET GRATES.

(b) Illinois Division of Highways.
(d) Laboratory investigation; applied research.
(e) Full scale model tests of four standard Division of Highways inlets. Original and revised inlet grate designs have been tested.
(h) Publication as a Civil Engineering Study is in progress.

(2086) A STUDY OF FISHWAYS.

(b) Departmental graduate study.
(d) Laboratory investigation; basic research.
(e) Scale model tests of a pool type fishway to determine efficient orifice design and ladder pool length.
(h) Preparation of final laboratory report is in progress.

(2087) EFFECTIVENESS OF SUBWAY GRATINGS FOR HIGHWAY DRAINAGE.

(b) Departmental special study.
(d) Laboratory investigation; applied research.
(e) Full scale model tests of two subway grating designs are being tested in standard Illinois Division of Highways, Type II inlet frame.
(f) Suspended temporarily.

(2088) DISCHARGE CHARACTERISTICS OF RECTANGULAR TYPE INLET BOXES.

(b) Departmental study.
(d) Laboratory investigation; basic research.
(e) Scale model investigation of rectangular inlet box with long lucite discharge pipe to verify or disprove the weir-orifice discharge theory.
(f) Suspended temporarily.

(2318) FAUBER BIRDGE MODEL STUDY.

(b) Departmental graduate study.
(d) Laboratory investigation; applied research.
(e) A design has been developed whereby a three tube culvert and an energy dissipator may replace an inadequate highway bridge. Model studies have been conducted to verify the proposed design.

(2319) FREQUENCY STUDY OF HYDROLOGIC DATA.

(b) Independent study.
(c) Dr. V. T. Chow, Civil Engineering Dept., University of Illinois, Urbana, Illinois.
(d) Basic and applied research.
(e) A survey of existing literature and applications of the log-probability law and a theoretical interpretation of the logarithmic normal distribution of hydrologic data. The method of analysis thus developed is applied to the runoff data of about forty small watersheds in the State of Illinois in order to expose the runoff characteristics of the watersheds.
(g) Results of the theoretical investigation include the derivation of characteristic values of the log-probability law and a theoretical interpretation of the logarithmic normal distribution of hydrologic data. Results of the analysis of runoff data obtained so far include the plotting of data and derivation of characteristic indexes of the runoff data.
(h) "The Log-Probability Law and its Engineering Applications", by Ven Te Chow, Proceedings ASCE, Separate No. 536, Nov. 1954.

(2790) SIDE CHANNEL SPILLWAY STUDY.

(b) Department graduate study.
(d) Laboratory investigation, applied research.
(e) Model investigation of flow conditions on the apron below the spillway crest and above the spillway channel. The purpose of the investigation is to determine the geometrics of the apron and the necessity of a critical depth control at the entrance to the spillway channel.

UNIVERSITY OF ILLINOIS, Fluid Mechanics and Hydraulics Laboratory.

Inquiries concerning Projects Nos. 1343 and 2083 should be addressed to Prof. S. M. Lansford, 219 Talbot Laboratory, and Projects Nos. 2320, 2321, 2536, and 2537, should be addressed to Prof. J. M. Robertson, 125 Talbot Laboratory, University of Illinois, Urbana, Illinois.

(1343) VELOCITY DISTRIBUTION STUDY IN A FLOOD-PLAIN CHANNEL.

(f) Inactive.

(2083) VELOCITY DISTRIBUTION IN AN OPEN CHANNEL HAVING A TRIANGULAR CROSS SECTION.

(b) Laboratory project.
(d) Basic research.
(e) Data were obtained from a channel artificially roughened.
(f) Suspended.
(h) "Some Observations on Open Channel Flow at Small Reynolds Numbers", discussion by W. M. Lansford and J. M. Robertson, Jour. of Eng. Mech., Div. ASCE, Vol. 83, EM 1, pp. 1154-5-13, January 1957.

(2320) TURBULENT BOUNDARY LAYER IN A DIFFUSER.

(b) Laboratory project.
(d) Experimental and analytical; basic research.
(e) Effect of adverse pressure gradient on the development of a turbulent boundary layer is being studied in a 10-degree conical diffuser. Air is the fluid medium being used.
(g) Thesis completed; additional tests in progress.
(h) "Development of the Turbulent Boundary-Layer in a Conical Diffuser", by Harvey R. Fraser. Paper presented at annual meeting ASCE, October 1957.

(2321) EFFECT OF ROUGHNESS ON VELOCITY PROFILE.

(b) Laboratory project.
(d) Analytical.
(e) A reanalysis of rough pipe velocity profiles in terms of the more recent concepts of boundary layer flow. Thus the inner wall region and outer region have been analyzed separately.
(f) Analysis completed.
(g) Some anomalies in Nikuradse's rough pipe data have been found. Need for additional experimental data.
(h) "The Turbulent Velocity Distribution in Rough Pipe", by J. M. Robertson. To be in Proc. of Fifth Midwest Conference on Fluid Mechanics, Ann Arbor, Mich., 1957.

(2536) STUDY OF HOMOLOGOUS TURBULENCE.

(b) National Science Foundation.
(d) Basic research.
(e) The nature of turbulence, its production and dissipation, are to be studied in the simplest possible shear flow. This is to be produced in plane conette flow in whick the shear is constant and the turbulence homogeneous but not isotropic.
(g) Tests under way.

(2537) WATER EXIT HYDROBALLISTICS.

(b) Office of Naval Research, Dept. of the Navy.
(d) Basic research; experimental.
(e) Information on water exit behavior of ellipsoidal bodies of fineness ratios 4 to 12 is being obtained photographically.
(g) Tests under way.

IOWA INSTITUTE OF HYDRAULIC RESEARCH, State University of Iowa.

(66) HYDROLOGIC STUDIES, RALSTON CREEK WATERSHED.

(b) Cooperative with Dept. of Agriculture, Geological Survey, and Iowa Highway Research Board.
(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.
(d) Field investigation; applied research, and master's theses.
(e) Study being made of relation between rainfall and runoff over a small area.

Discharge from a 3-square-mile area measured by U. S. Geological Survey; rainfall records at five automatic recording stations collected by Soil Conservation Service. Continuous records since 1924 of precipitation, runoff, ground water levels, and vegetal cover.

(g) Yearly records available for examination at Iowa Institute of Hydraulic Research.

(h) Reports prepared annually since 1924 available in files at the Iowa Institute of Hydraulic Research.

(67) COOPERATIVE SURFACE-WATER INVESTIGATIONS IN IOWA.

(b) Cooperative with Geological Survey.

(c) Mr. V. R. Bennion, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Field investigation; collection of basic stream-flow data.

(e) Stream-flow and sediment measuring stations maintained throughout the State of Iowa cooperatively on a continuous basis. Records collected by standard methods of U.S. Geological Survey.

(g) Records of stream flow and sediment discharge computed yearly.

(h) Records contained in Water-Supply Papers available through office of the Geological Survey.

(68) HYDROLOGIC STUDIES, RAPID CREEK WATERSHED.

(b) Cooperative with Dept. of Agriculture and Geological Survey.

(c) Mr. V. R. Bennion, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Field investigation; applied research and master's theses.

(e) Study being made of relation between rainfall and runoff over a small area. Discharge from a 25-square-mile area measured and flood runoff on main sub-basins determined by U. S. Geological Survey; rainfall records at four automatic recording stations collected by U. S. Weather Bureau. Continuous records since 1941 of precipitation, runoff, and ground-water levels.

(g) Rainfall records published in Weather Bureau Climatological Bulletins and surface runoff and ground-water levels published in Geological Survey Water-Supply Papers.

(73) MEASUREMENT OF TURBULENCE IN FLOWING WATER.

(b) Cooperative with Office of Naval Research, Department of the Navy.

(c) Dr. Philip G. Hubbard, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental and theoretical.

(e) Instruments, primarily electrical in operation, are being developed to measure the characteristics of turbulent flow under a wide range of laboratory and field conditions. Both sensing and computing elements are involved.

(g) Complete analysis of the sensing element operation and the circuit performance and

descriptions of finished instruments are presented in the publication below.

(h) "Operating Manual for the Hot-Wire and Hot-Film Anemometers", P. G. Hubbard, State University of Iowa Studies in Engineering, Bulletin 37, 1957.

(79) CAVITATION.

(b) Cooperative with Office of Naval Research, Department of the Navy.

(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental and theoretical; basic research and graduate theses.

(e) Basic information is sought on cavitation for systematically varied boundary conditions. Tests are conducted in two variable-pressure water tunnels and a special cavitation tank. Studies of high-velocity submerged jets are being continued, with supplementary measurements of pressure fluctuation in air; instrumentation is being developed for measurement of the correlation between the velocity and pressure fluctuations to make possible prediction of the incipient cavitation index for given mean-flow conditions. Previous measurements of the pressure distribution around rounded, ellipsoidal, and conical head forms are being extended in one tunnel to various angles of yaw. Previous measurements on normal cylinders are being extended through use of dynamometer in other water tunnel.

(h) "Pressure and Velocity Fluctuations in a Submerged Jet", S. R. Carr, M. S. Thesis, August 1957.

(81) MATHEMATICAL ANALYSIS OF PRESSURE DISTRIBUTION.

(b) Cooperative with Office of Naval Research, and David Taylor Model Basin, Department of the Navy.

(c) Dr. Louis Landweber, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Theoretical; basic research.

(e) (1) A theory of stream functions for general three-dimensional flow has been developed and published. (2) The development of a method for the determination of flow about bodies of revolution and symmetrical two-dimensional forms in arbitrary states of motion, based on solutions of integral equations of the first kind, has been completed and a description of the method will be submitted for publication. (3) An analog computer for potential flow, consisting of an array of electrical resistances, has been constructed. A manual describing its application has been prepared.

(h) "Operating Manual for the IIHR Finite Difference Network Analog", P. G. Hubbard, Iowa Institute of Hydraulic Research Contract Report, April 1957.
"Stream Functions in Three-Dimensional Flows", Chia-Shun Yih, La Houille Blanche, July-August 1957.

(854) BOUNDARY-LAYER DEVELOPMENT ON SMOOTH AND ROUGH SURFACES.

(b) Cooperative with Office of Naval Research, Department of the Navy.
(c) Dr. Louis Landweber, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Experimental and theoretical; basic research.
(e) Purpose of work is to determine the relations between boundary-layer characteristics for smooth and rough boundaries of arbitrary shape. A critical study of the boundary layer on a smooth flat plate in zero pressure gradient has been completed and a report written. The boundary-layer on a smooth circular cylinder with axis parallel to the stream, in a zero pressure gradient, has also been investigated.
(h) "Generalization of the Logarithmic Law of the Boundary Layer on a Flat Plate", L. Landweber, Schiffstechnik Bd. 4, Heft 21, 1957.
"Comparison of Two Analyses of Boundary-Layer Data on a Flat Plage", L. Landweber and T. T. Siao, Proceedings of the Eighth International Towing Tank Conference, Madrid, Sept. 1957; to be published in Journal of Ship Research.

(1102) HISTORY OF HYDRAULICS.

(b) Institute project.
(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(e) To trace the historical development of the important theories of hydraulics, covering the fundamental ideas of the science, the critical periods of its development, and the personalities whose contributions were of major importance.
(f) Completed.
(h) "History of Hydraulics", Hunter Rouse and Simon Ince, published by the Iowa Institute in the fall of 1957 as 280-page book retailing at $5.00 per copy.

(1107) TRANSPORTATION OF SEDIMENT AS SUSPENDED AND TOTAL LOAD.

(b) Laboratory project; formerly cooperative with the Office of Naval Research.
(c) Dr. Emmett M. Laursen, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Experimental; basic research.
(e) To determine the suspended and total load as a function of hydraulic and sediment parameters.
(f) Suspended.
(g) An empirical relationship has been found for the suspended, bed, and total load as a function of the velocity and depth of flow, the shear velocity, the sediment size and the fall velocity.
(h) "An Investigation of the Total Sediment Load", E. M. Laursen, Final Report to the Office of Naval Research, June 15, 1957.

(1870) EFFECT OF SHAPE OF VERTICAL DRAFT TUBES ON THEIR EFFICIENCY.

(b) Laboratory project.
(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.
(d) Experimental; master's thesis.
(e) Comparative study of conical, Prasil, White, and Moody draft-tube efficiency under identical conditions.
(f) Completed.
(g) Results of tests on conical and Prasil tubes have been compared.
(h) "Relative Efficiency of Draft Tube Forms", Benoyendra Chanda, M. S. Thesis, State University of Iowa, 1955. Available on loan.

(1871) CAVITATING FLOW AROUND HYDROFOILS.

(b) David Taylor Model Basin, Dept. of the Navy.
(c) Dr. Louis Landweber, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Experimental and theoretical.
(e) Purpose is to obtain forces and moments on cavitating hydrofoils at various angles of attack. Hydrofoils are tested in a variable-pressure water tunnel on a balance which records electrically the instantaneous forces on the models. One hydrofoil of the NACA 66-series has been tested and the results compared with a linearized theory of cavitating hydrofoils.
(f) Completed.
(h) "Theoretical and Experimental Investigation of Forces on Cavitating Hydrofoils", Michel Hug, Ph. D. dissertation, State University of Iowa, February 1956. Available on loan.
"Water-Tunnel Tests of a Cavitating Hydrofoil", Tsuyoshi Matsuoka, M. S. Thesis, State University of Iowa, August 1957. Available on loan.

(1875) CHARACTERISTICS OF STABLE EDDIES.

(b) Laboratory project, partially supported by Office of Naval Research, Department of the Navy.
(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.
(d) Experimental and analytical; basic research for doctoral dissertation.
(e) Distributions of velocity, pressure, and turbulence are being measured in an air tunnel and analyzed throughout the vicinity of separation zones produced by abrupt changes in flow section, to the end of establishing the primary eddy characteristics as functions of the boundary geometry.
(g) Mean eddy patterns at conduit enlargements, behind normal plates, in the wakes of jets, and in the hydraulic jump have been investigated.
(h) "Diffusion in the Lee of a Two-Dimensional Jet", Hunter Rouse, Proceedings Ninth International Congress of Applied Mechanics, Brussels, 1957.
"Turbulence Characteristics of the Hydraulic Jump", Hunter Rouse, T. T. Siao and S. Nagaratnam, Journal of Hydraulics, ASCE, February 1958.

(2091) RESEARCH ON SHIP THEORY.

(b) Cooperative with Office of Naval Research,
     Dept. of the Navy, and the Society of
     Naval Architects and Marine Engineers.
(c) Dr. Louis Landweber, Iowa Institute of
     Hydraulic Research, Iowa City, Iowa.
(d) Experimental and theoretical basic research.
(e) Purpose is to determine the laws governing
     the forces, moments, and motions of ships
     in smooth and disturbed seas, in order to
     furnish design data to the naval architect.
     A towing tank 10 feet wide, 10 feet deep,
     and 300 feet long has been constructed.
     Theoretical work on the added-mass coeffi-
     cients and the forces and moments on
     bodies is under way. Equipment has been
     prepared for investigating the rolling of
     ships.
(h) "Added Mass of Lewis Forms Oscillating in
     a Free Surface", L. Landweber, Proceedings
     of the Symposium on the Behavior of Ships
     in a Seaway, Netherlands Ship Model Basin,
     September 1957.
     "Added Mass of Two-Dimensional Forms
     Oscillating in a Free Surface", L.
     Landweber and M. C. de Macagno, Journal of
     Ship Research, Vol. 1, No. 3, 1957.

(2320) A STUDY OF THE FLOW CHARACTERISTICS OF
        HIGHWAY CULVERTS.

(b) Iowa Highway Research Board and U. S.
     Bureau of Public Roads.
(c) Prof. D. E. Metzler, Iowa Institute of
     Hydraulic Research, Iowa City, Iowa.
(d) Experimental; applied research.
(e) The purpose is to determine the flow
     characteristics of box culverts.

(2322) EFFECT OF RESERVOIR STORAGE UPON SUPER-
        FLOODS.

(b) Graduate project.
(c) Prof. C. J. Posey, Dept. of Mechanics and
     Hydraulics, State University of Iowa,
     Iowa City, Iowa.
(d) Theoretical, master's thesis.
(e) To find what effect reservoirs of various
     characteristics will have in decreasing
     the peak of increasingly greater super-
     floods.
(g) A quick approximate method has been de-
     vised which takes the principal variables
     into account.
(h) "Investigation of Storage Effect of Reser-
     voirs Subjected to Superfloods", S. Dola,
     M. S. Thesis, State University of Iowa,
     Feb. 1957. Available on loan.

(2323) FORMULATION OF STANDARDS FOR RESERVOIR
        SAFETY.

(b) Graduate project.
(c) Prof. C. J. Posey, Dept. of Mechanics and
     Hydraulics, State University of Iowa,
     Iowa City, Iowa.
(d) Theoretical, master's thesis.
(e) There are standard unit stresses and load-
     ings for buildings used by the public, but

none for the design of reservoirs that may
menace populous communities. The possibil-
ity of formulating such standards will be
explored.
(g) Master's thesis completed which deals
     primarily with hydrologic aspects of the
     problem, including application of distri-
     bution graph method to this particular
     problem.
(h) "Hydrologic Safety Standards for Spillway
     Capacity", O. M. Erickson, M. S. Thesis,
     State University of Iowa, August 1957.
     Available on loan.

(2324) ANALYSIS OF FLOW PATTERNS FOR SHARP-CRESTED
        WEIRS.

(b) Laboratory project.
(c) Dr. Hunter Rouse, Iowa Institute of
     Hydraulic Research, Iowa City, Iowa.
(d) Analytical and experimental; basic research
     for doctor's and master's degrees.
(e) Determination of streamline configuration
     by means of relaxation process and elec-
     trical analog computer for various rela-
     tive heights of weirs, supplemented by
     experimental study for relatively low weirs
     and sills.
(f) Experimental study of low weirs and sills
     completed.
(h) "Characteristics of Flow over Terminal
     Weirs and Sills", P. K. Kandaswamy and
     Hunter Rouse, Journal of the Hydraulics
     Division, ASCE, August 1957.

(2328) INVESTIGATION OF SURFACE ROUGHNESS.

(b) Cooperative with U. S. Geological Survey.
(c) Dr. Hunter Rouse, Iowa Institute of
     Hydraulic Research, Iowa City, Iowa.
(d) Experimental research for doctoral disser-
     tation.
(e) Initial purpose is to determine effect of
     areal distribution of roughness elements
     on resistance in both subcritical and
     supercritical flow. Tests are being con-
     ducted on cubical elements cemented to
     floor of 30-foot tilting flume in varying
     concentration.

(2538) EFFECT ON ANTECEDENT MOISTURE AND INTENSITY
        OF RAINFALL ON INFILTRATION RATES ON RAPID
        CREEK.

(b) Laboratory project.
(c) Prof. J. W. Howe, Dept. of Mechanics and
     Hydraulics, State University of Iowa,
     Iowa City, Iowa.
(d) Analysis of hydrologic records, applied
     research for master's thesis.
(e) The purpose is to determine the correla-
     tion of antecedent moisture index and
     rainfall intensity with an infiltration
     index derived by Song (M. S. thesis, 1956).

(2539) EFFECT OF ANTECEDENT MOISTURE AND INTENSITY
        OF RAINFALL ON INFILTRATION RATES ON
        RALSTON CREEK.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Analysis of hydrologic records, applied research for master's thesis.

(e) The purpose is to determine the correlation of antecedent-moisture index and rainfall intensity with an infiltration index derived by Johnson.

(h) "Infiltration Frequency on Ralston Creek Watershed", H. P. Johnson and J. W. Howe, A.G.U., Vol. 37, No. 5, p. 593.

(2540) SCOUR AT BRIDGE CROSSINGS.

(b) Cooperative with Iowa Highway Research Board and U. S. Bureau of Public Roads.

(c) Dr. Emmett M. Laursen, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental; applied research.

(e) To investigate the pattern of general scour caused by contracting the flow section at a bridge crossing.

(g) Preliminary results indicate that the depth and shape of the scour hole are functions of the geometry of the bridge site and the ratio of the flow in the normal channel to that on the floodplain.

(2541) DEVELOPMENT OF INSTRUMENTS FOR USE IN ANALYZING APERIODIC SIGNALS.

(b) Cooperative with Office of Naval Research, Department of the Navy.

(c) Dr. Philip G. Hubbard, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental; applied research.

(e) The purpose is to improve the analysis of turbulent velocity and pressure fluctuations.

(2791) MIXING IN STRATIFIED FLOW.

(b) Cooperative with Office of Ordnance Research, Department of the Army.

(c) Dr. Hunter Rouse, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Basic research; experimental.

(e) To determine the characteristics of mixing, due to inherent instability, at the interface of stratified shear flow.

(2792) THE DECAY OF TURBULENCE IN A ZERO-MOMENTUM WAKE.

(b) Cooperative with the Office of Naval Research, Department of the Navy.

(c) Dr. Philip G. Hubbard, Iowa Institute of Hydraulic Research, Iowa City, Iowa.

(d) Experimental.

(e) Powered models are driven through a towing basin, and the wake is explored with a hot-wire anemometer.

(2793) FLOOD INSURANCE.

(b) Graduate project.

(c) Prof. C. J. Posey, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Theoretical, master's thesis.

(e) The feasibility of various flood insurance plans will be investigated from the engineering viewpoint.

(2794) STUDY OF BACKWATER CURVE DATA.

(b) Graduate project.

(c) Prof. C. J. Posey, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Analysis of experimental data; basic, master's thesis.

(e) Analysis of backwater curves incidentally obtained in 400-foot variable-slope flume of Rocky Mountain Hydraulic Laboratory.

(2795) PREDICTION OF RUNOFF FREQUENCIES FROM PRECIPITATION AND INFILTRATION FREQUENCIES.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Analytical statistical study, master's thesis.

(e) Correlation of actual runoff frequencies with rainfall and infiltration frequencies estimated by statistical analyses to test possibility of estimating actual frequencies of large floods.

(2796) EXTENSION OF WIND TUNNEL STUDIES ON PRESSURE DISTRIBUTION ON FLAT ROOFED, RECTANGULAR BUILDINGS.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Experimental, basic research, master's thesis.

(e) Rectangular, flat roofed building models having height:width ratios from 1/2 to 6 and length:width ratios from 1 to 4 exposed to uniform wind velocity in tunnel. Pressure variations at 3 orientations observed.

(2797) OPTIMUM SHAPE OF 90° BEND IN RECTANGULAR CHANNEL.

(b) Laboratory project.

(c) Prof. J. W. Howe, Dept. of Mechanics and Hydraulics, State University of Iowa, Iowa City, Iowa.

(d) Experimental, basic, master's thesis.

(e) Determination of optimum shape of 90° rectangular canal bend for minimum head loss due to bend.

IOWA STATE COLLEGE, Department of Agricultural Engineering.

Inquiries concerning Projects Nos. 2330 to 2334, inclusive, should be addressed to Mr. H. P. Johnson, Dept. of Agricultural Engineering, Iowa State College, Ames, Iowa.

(2330) DEPTH, SPACING AND HYDRAULICS OF TILE DRAINS.

    (b) Laboratory project.
    (d) Theoretical and field investigation; basic and applied research; master's and doctoral theses.
    (e) Analytical and physical approach is being studied to determine depth and spacing of tile drains by analyzing geometry of systems and soil characteristics. Analogues and field measurements of rate of drop of water tables between drains are being studied. Studies of effect of tile misalinement and observations of nature of flow in field tile lines are being made.
    (g) On heavy soils tile affect drainage very little more than one day after saturating rainfall. Resulting water table almost level.
    (h) "Effect of Tile Spacing on Crop Yield and Water Table Level in a Planosol Soil", G. O. Schwab, Don Kirkham, and H. P. Johnson. Soil Science Society of America Proceedings, Vol. 21, No. 4, pp. 448-452, July-August 1957.

(2331) ESTIMATION OF SURFACE RUNOFF FROM AGRICULTURAL WATERSHEDS.

    (b) Laboratory project.
    (d) Theoretical; applied research; doctoral thesis.
    (e) The surface runoff volume for individual storms is being estimated by superimposing an infiltration curve on the rainfall histogram. Data from point rainfall records is being analyzed. Hydrographs from watersheds of up to 25 square miles are being collected and analyzed.

(2333) IMPROVEMENT OF SURFACE DRAINAGE WITH TILE BLIND INLETS.

    (b) Laboratory report.
    (d) Field investigation; design.
    (e) Field study is being made to determine the effect of different backfill materials on the flow of water to tile drains.

(2334) RUNOFF FROM SMALL WATERSHEDS.

    (b) Laboratory project, cooperative with Agricultural Research Service, USDA.
    (d) Field investigation; applied research, design.
    (e) Measurements are being made of watershed rainfall and surface runoff on 10 agricultural watersheds. Sediment measurements are being made in 6 small reservoirs in the gaged watersheds.
    (g) Eight years of measurement completed.
    (h) "A Runoff Sampler for Large Watersheds", K. K. Barnes and H. P. Johnson, Journal American Society of Agricultural Engineers, Vol. 37, No. 12, pp. 813-815, 824, Dec. 1956.

THE JOHNS HOPKINS UNIVERSITY, Applied Physics Laboratory.

Inquiries concerning Projects Nos. 1876, 1877, and 2335, should be addressed to The Director, Applied Physics Laboratory, The Johns Hopkins University, 8621 Georgia Avenue, Silver Spring, Maryland

(1876) ANALYSIS OF DYNAMIC OPERATION OF HYDRAULIC (FORCE) AMPLIFIER TRANSFER VALVES.

    (b) Bureau of Ordnance, Dept. of the Navy.
    (d) Theoretical and experimental; applied research and development.
    (e) Designed to develop a set of linearized differential equations to describe the operation of single and double nozzle type, hydraulic force amplifier, transfer valves.
    (f) Suspended.
    (g) The linearization of differential equations complete. Have been completed and compare favorably with experimental results.
    (h) Second report on complete equations and their linearization in process.

(1877) ANALYSIS OF STATIC AND DYNAMIC OPERATING CHARACTERISTICS OF HYDRAULIC SERVO-MECHANISMS.

    (b) Bureau of Ordnance, Dept. of the Navy.
    (d) Theoretical and experimental, applied research and design.
    (e) Phase (1) covers derivation of equations required in item 1876 above. Phase (2) covers the application of simple linearized equations to study the effects of complex mechanical loads and oil compressibility. Phase (3) covers the use of more sophisticated describing function techniques to analyze the nonlinear characteristics of transfer valve while operating in a closed loop and driving complex mechanical loads and including the effects of oil compressibility. Phase (3) includes single stage and two stage hydraulic transfer valves. The work under Phase (3) is being carried out by McDonnell Aircraft Corporation, St. Louis, Mo., under technical cognizance of APL/JHU.
    (f) Phase (2) completed. Phase (3) single stage valve completed, two stage valve suspended.
    (g) Phase (2), linearized differential equations produce reasonable correlations between experiment and theory for small changes in variables. Phase (3) describing function techniques have been successfully applied to transfer valve hysteresis, spool reaction forces, and square root characteristics, etc.
    (h) Phase (2); no unclassified report. Phase (3) Contract No. NOrd 12826. Single Stage Valve - MAC Report Nos. 4580, 4581. Two Stage Valve - report in process.

(2335) APPLICATION OF SWITCHING TECHNIQUES TO HYDRAULIC CONTROL SYSTEMS.

    (b) Bureau of Ordnance, Dept. of the Navy.

(d) Theoretical and experimental; applied development and design.

(e) Study of the dynamic properties of an acceleration switching hydraulic servo while operating in a closed loop under the presence of various external loads and environmental conditions on the transfer valve and output actuator.

(g) The use of a two stage transfer valve and actuator as a double integrating switch has been found to have superior static and dynamic performance characteristics under normal and adverse environmental conditions (ambient temperature to 700° F) over the proportional flow control valve.

(h) "Design and Performance Criteria of the Acceleration Switching Hydraulic Servo", by Woodrow Seamone, APL/JHU CF-2652, dated June 19, 1957.

THE JOHNS HOPKINS UNIVERSITY, School of Engineering.

(856) HYDROLOGY OF STORM DRAINAGE SYSTEMS IN URBAN AREAS.

(b) Baltimore City, Baltimore County, and United States Bureau of Public Roads.

(c) Dr. John C. Geyer, Dept. of Sanitary Engineering and Water Resources, The Johns Hopkins University, Baltimore 18, Md.

(d) Field investigation; basic research, and design.

(e) Study of rainfall and runoff relationships as affected by various drainage area parameters. At present, runoff from seven urban areas ranging in size from ten to four hundred acres is gaged by stage measurement. Two recording systems which simultaneously record rainfall on and runoff from fourteen inlet areas provide opportunity for detailed study. About six years of rainfall records now exist for a network of ten recording gages covering an area of about fifty square miles.

(g) A new method known as the Inlet Method of estimating quantity of storm water on urban drainage areas is being studied. The Inlet Method is based on three years of Baltimore rainfall-runoff measurements on fourteen inlet areas and three small urban drainage areas. The method consists of three parts: (1) Determining the peak flow to each inlet based on a maximum five minute rainfall intensity, (2) attenuating the flow peak from each sub-area (group of inlet areas) as it moves down the pipe, and (3) summing each inlet hydrograph to determine the total hydrograph at the design point.
The Inlet Method can be used for storms moving in any direction, localized storms and for determining the effects of urbanization on different sub-areas. A quick mass-production method can be set up to compute flows for past and future hypothetical storms on a given drainage area. Experimental data so far include urban-type areas on slopes between 2 and 7%,

steep roofs, $i_5 > 3.00$ in./hr, inlet area imperviousness between 30% and 70%. Experimental data are needed for flat areas, and flat roofs, for $I < 30\%$ and $I > 70\%$. (I) represents the percentage of imperviousness and (15) is the maximum five minute rainfall intensity in inches per hour.

(h) "Progress Report on the Storm Drainage Research Project" to be published in Feb. 1958, Paul Bock, Dept. of Sanitary Engineering and Water Resources, The Johns Hopkins University, Baltimore 18, Md. A limited number of copies will be available.

THE JAMES LEFFEL AND COMPANY.

(2336) DRAFT TUBE DEVELOPMENT.

(b) Laboratory project.

(c) Mr. J. Robert Groff, The James Leffel and Co., 426 East St., Springfield, Ohio.

(d) Experimental and applied research.

(e) Program for testing of propeller type, also medium and lower speed hydraulic turbines for horsepower, efficiency, thrust, torque, runaway speed and leakage on various kinds of draft tubes and in different kinds of casings. Also a study of draft tube action and ways and means of improving of such action with regard to the simplest possible operation of hydraulic turbine units.

LEHIGH UNIVERSITY, Department of Civil Engineering.

Inquiries concerning the following projects should be addressed to Prof. W. J. Eney, Dept. of Civil Engineering, Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pa.

(1602) PRESSURE DISTRIBUTION IN CONDUIT BENDS.

(b) Laboratory project.

(d) Experimental; undergraduate special problem.

(e) Study of a rectangular bend with a central dividing wall, by means of electrical analogy has been completed.

(f) Inactive.

(h) "Investigation by Electrical Analogy of Potential Flow in a 90° Elbow with a Dividing Vane", by J. W. Glomb, undergraduate problem, Lehigh University Library, May 1957.

(1603) BUTTERFLY VALVE STUDY.

(b) CDC Controls Services, Incorporated, Hatboro, Pennsylvania.

(d) Experimental; applied research.

(f) Completed.

(h) "Butterfly Valve Flow Characteristics", by M. B. McPherson, H. S. Strausser, and J. C. Williams, Proceedings American Society of Civil Engineers, Sep. No. 1167, February 1957.

(2339) BUCKET-TYPE ENERGY DISSIPATOR CHARACTERIS-
TICS.

(b) Gannett, Fleming, Corddry and Carpenter,
Inc., 600 North Second Street, Harrisburg,
Pennsylvania.
(d) Experimental; for general design.
(h) "A Study of Bucket-Type Energy Dissipator
Characteristics", by M. B. McPherson and
M. H. Karr, ASCE Proceedings, Sep. No.
1266, June 1957.

(2543) STUDY OF CONDUIT EXIT PORTALS.

(b) Laboratory project.
(d) Experimental; M. S. Thesis.
(f) General Press-Distribution study completed.
(g) Tests of square and circular conduit with
free-jet, horizontal apron, and three dif-
ferent wall flares, have been completed.
(h) "Exit Portal Pressure Study", by A. R. R.
Morel, M. S. Thesis, Lehigh University
Library, June 1957.
"Outlet Portal Pressure Distribution", by
M. B. McPherson and Alain R. R. Morel,
paper to be presented at ASCE Meeting in
Chicago, February 1958.

(2798) STUDY OF BROAD-CRESTED WEIRS.

(b) Laboratory project.
(d) Experimental; for design.
(f) Completed.
(h) "Discussion of Seven Exploratory Studies
in Hydraulics", by M. B. McPherson and
R. G. Dittig, ASCE Proceedings, Sep. No.
1230, April 1957.

LOUISIANA STATE UNIVERSITY AND A AND M COLLEGE,
Agricultural Engineering Department.

(2340) HOSE TESTS.

(b) Cooperative with State Anhydrous Ammonia
Commission.
(c) Prof. Harold T. Barr, Head, Agricultural
Engineering Dept., Louisiana State Univer-
sity, Baton Rouge 3, La.
(d) Experimental and applied research.
(e) To determine suitability of hose for anhy-
drous ammonia service. Hose is subjected
to anhydrous ammonia, flexed in a special-
ly designed machine, then proof tested.
(g) Regulatory bodies such as the Louisiana
Anhydrous Ammonia Commission are using
results of tests as criteria for approval
or disapproval of hose sold for use with
anhydrous ammonia.

(2799) CAPACITY OF ANHYDROUS AMMONIA VALVES.

(b) The Anhydrous Ammonia Commission of
Louisiana and interested valve manufac-
turers.
(c) Prof. Harold T. Barr, Head, Agricultural
Engineering Dept., Louisiana State Univer-
sity, Baton Rouse 3, La.
(d) Experimental and applied research.

(e) Valves submitted to the laboratory are
rated for capacity and for safety. Results
are made available to the Anhydrous Ammonia
Commission of Louisiana and to the manufac-
turers concerned. Vapor capacities are
determined with compressed air, liquid
capacities with water.
(g) Standards are being established for rating
and labeling anhydrous ammonia valves.

(2800) HEAD LOSS DUE TO QUICK COUPLERS IN ALUMINUM
IRRIGATION PIPE.

(b) Cooperative with Civil Engineering.
(c) Mr. William F. Lytle, Agricultural Engi-
neering Dept., Louisiana State University,
Baton Rouge 3, La.
(d) Experimental.
(e) To determine what head loss is caused by
addition of quick couplers to aluminum
irrigation pipe. Manufacturers give quite
a range of loss due to couplers. Some
work has been done in testing couplers in
3-inch O.D. pipe. A complete series of
tests is to be run on 3-, 4-, 5-, and 6-
inch couplers. Pilot tests have been run
to check the experimental setup. The
main series of tests will begin in the
spring of 1958.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Dept. of
Civil and Sanitary Engineering, Hydrodynamics
Laboratory.

Inquiries concerning Projects Nos. 577, 578, 2103,
2547 to 2549, incl., 2801 and 2802, and requests
for reprints and Technical Reports should be
addressed to Dr. Arthur T. Ippen, Professor of Hy-
draulics, Massachusetts Institute of Technology,
Cambridge 39, Mass..

(307) STABILITY OF FLOW STRATIFIED DUE TO
DENSITY DIFFERENCES.

(b) Laboratory project.
(c) Prof. D. R. F. Harleman, Mass. Inst. of
Technology, Cambridge 39, Mass.
(d) Theoretical and experimental; graduate re-
search.
(e) (1) Theoretical and experimental investiga-
tions have been made on steady-state uni-
form density current flows including de-
termination of velocity distributions,
resistance laws and interfacial stability.
(2) Investigation of control structures
for stratified flow. (3) Investigation of
vertical intake structures for stratified
flow.
(g) Initial studies on phase (2) were concerned
with the design of curtain walls for con-
denser water intakes in which the source
of water consists of a warm layer over-
lying a cold layer. Experiments to deter-
mine the maximum rate of flow which can be
discharged under the curtain wall without
drawing in water from the upper layer have
been completed. In phase (3) vertical in-
takes for a two layer stratified system

having a density difference of the order of one percent have been investigated experimentally. Interface drawdown curves and critical discharge rates have been obtained for various intake geometries.

(h) "Characteristics of Intakes near a Density Interface", by H. Arnold, Jr. and P. Donohoe, M. Sc. Thesis, 1957.

(577) CHARACTERISTICS OF SOLITARY WAVES.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; basic research.
(e) (1) Experimental investigation of solitary wave characteristics in a horizontal channel. Measurements of attenuation for various bottom roughnesses. (2) Investigation of amplitude change, profile deformation and breaking characteristics of the solitary wave on a sloping beach. (3) Measurement of unsteady velocities in the boundary layer region. (4) Experimental investigation of wave characteristics in the transition between oscillatory and solitary waves. (5) Investigation of the unsteady boundary shear due to the passage of a solitary wave.
(f) Completed.
(g) Phase (5) has been completed. Instantaneous force measurements by means of a shear plate on the channel bottom have been made. A comparison with average resistance coefficients obtained in phase (1) was made and satisfactory correlation was found. Due to the unsteady nature of the flow under the solitary wave, the instantaneous shear stresses cannot adequately be described by steady state relations except at the point of zero acceleration under the crest.
(h) "Application of the Solitary Wave Theory to Shoaling Oscillatory Waves", J. G. Housley and D. C. Taylor, American Geophysical Union, Trans. February 1957.
"The Effect of Boundary Resistance on Solitary Waves", A. T. Ippen and G. Kulin, La Houille Blanche No. 3, July-August 1957.
"Measurements of Bottom Shear Stresses Under Solitary Waves", M. Mitchell and J. Housley, Mc. Sc. Thesis, 1957.

(578) TURBULENCE MEASUREMENTS IN FREE SURFACE FLOW.

(b) Office of Naval Research, Department of the Navy.
(d) Experimental; development of instrumentation.
(e) Studies of turbulence characteristics in open channel flow.
(f) Completed.
(g) Turbulence measurements in water with a Pitot tube-pressure cell combination have been obtained with a frequency response of the order of 150 cps. Oscilloscope records have been analyzed by means of a digital computer and auto-correlation curves, mean intensity spectra and macroturbulence scale have been obtained. The results compare favorably with the work of other investiga-

tors in air.
Additional experiments on the turbulence characteristics in the wake of a cylinder in supercritical open channel flow have been made. The decay of wake turbulence with distance downstream has been obtained by studying variations in the scale of macroturbulence.

(h) "Some Turbulence Measurements in Water with an Impact Tube-Pressure Cell Combination", A. T. Ippen and F. Raichlen, Proc. ASCE. Vol. 83, No. HY 5, October 1957.

(1355) CAVITATION INCEPTION FOR STEADY MOTION.

(b) Office of Naval Research, Department of the Navy.
(c) Prof. J. W. Daily, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental; basic research.
(e) Cavitation inception for steady motion is being studied for systematic variations in boundary layer development and in the turbulence level for the zone of minimum pressure.
(g) A closed-jet water tunnel with a rectangular test section has been developed. The working section is arranged so that the boundary layer growth is controlled by a systematic change of its shape. Provision is also made for control of turbulence level, pressure intensity and air content. Experiments involving the effect of velocity variation on incipient cavitation and on the influence of dissolved air content have been completed. Information on the turbulence of the flow in the cavitation region has been obtained by high-speed photographs of the cavitation bubbles. Explorations in the boundary layer are being made to determine the local mean pressure intensities and their relation to the local velocity and turbulence. It is planned to extend this investigation to include cases of boundary roughness.

(1609) EXPERIMENTAL STUDY OF THE SORTING OF BEACH SEDIMENTS BY WAVE ACTION.

(b) Beach Erosion Board, U. S. Army Corps of Engineers.
(c) Prof. P. S. Eagleson, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental basic research.
(e) Quantitative study of the sorting action and selective transport of beach material by shallow water waves moving on a plane, granular beach.
(g) Equipment consists of a wave channel 30 inches wide, 36 inches deep and 100 feet in length together with a piston-type wave generating mechanism. The wave generator is controlled by a hydraulic servomechanism which permits continuous variation of both wave amplitude and frequency during operation.
A systematic series of observations of velocities of spherical bottom sediment

particles for a horizontal bottom and two beach slopes has been completed for various surface roughnesses including a smooth beach.

The data are shown to verify a derived equation of net sediment motion.

A study of bottom resistance is currently underway involving direct measurement of boundary shear stress and boundary layer velocity distribution.

(h) "Resistance Coefficients for Spheres on a Plane Boundary", J. J Carty, Jr., B. S. Thesis, 1957.

"The Mechanics of the Motion of Discrete Spherical Bottom Sediment Particles Due to Shoaling Waves", P. S. Eagleson, R. G. Dean, and L. A. Peralta, Technical Report No. 26, Hydrodynamics Laboratory, MIT, 1957.

(1881) WAVE FORCES ON OFFSHORE STRUCTURES.

(b) Humble Oil and Refining Co., Houston, Tex.
(c) Prof. D. R. F. Harleman, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental; basic research.
(e) Objective is the determination of the design forces to be expected on offshore structures subjected to shallow water wave action.
(g) Experimental equipment includes a 100-foot wave tank, an oscillatory wave generator of variable amplitude and frequency and dynamic lift and drag balances for the measurement of forces due to wave motion. Tests have been completed on a series of vertical cylinders in waves of various characteristics. Lift and drag measurements have also been made on horizontal and vertical cylinders with variable submergence and on basic shapes such as spheres and cylinders.

Various configurations of bouyancy members for a movable platform have been tested to obtain dynamic forces when the platform is rigidly fixed. Tests have been extended to include a study of mooring cable forces on a floating platform subjected to wave forces. A study is underway on the dynamics of partially restrained submerged objects in waves.

(h) "An Experimental Determination of Particle Velocities in the Oscillatory Water Wave", T. A. Marlow, II, M. Sc. Thesis, 1957.

(2103) ENERGY DISSIPATION IN STILLING BASINS AND DOWNSTREAM EROSION.

(b) Laboratory project.
(d) Experimental; graduate theses.
(e) General study of energy dissipation in stilling basins and erosion conditions downstream.
(g) Hydrodynamic forces on a single baffle pier have measured as a function of the initial Froude number and the distance between the toe of the hydraulic jump and the pier. Additional studies have also been made on the arrangement and position of baffle

piers in stilling basins.

Studies on the similitude characteristics of rip rap regions below stilling basins have been made. Flow and sediment (gravel) characteristics at incipient motion are correlated with particle fall velocity, particle edge velocity, energy gradient, specific gravity and relative roughness.

(h) "Similitude in Incipient Motion", by R. A. Roberge and E. D. Peixotto, M. Sc. Thesis, 1956.

(2341) FLUID MECHANICS OF TURBOMACHINERY COMPONENTS.

(b) Office of Ordnance Research, Department of the Army.
(c) Prof. J. W. Daily, Prof. R. E. Nece, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental; basic research.
(e) Investigation of problems connected with the several secondary effects in a turbomachine such as seal ring friction and leakage, rotor-to-wall clearance effects, and vane tip clearance.
(g) The investigation is concerned with the effect of roughness, chamber dimensions and disk shape on disk friction. Torque tests have been conducted over a wide range of disk Reynolds numbers for smooth and rough disks of 19-3/4 inches diameter rotating within a symmetrical casing at various disk-to-wall clearances. Both plane and tapered disks have been tested. Pressure and velocity distribution measurements within the chamber are being made for correlation with theoretical and experimental determinations of friction and torque.

(2342) DIFFUSION OF SUBMERGED JETS WITH DENSITY DIFFERENCES.

(b) Laboratory project.
(c) Prof. D. R. F. Harleman, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental and analytical; basic research.
(e) General study of the diffusion of submerged jets whose density is either greater or less than that of the surrounding fluid.
(g) A series of experiments have been made on the diffusion characteristics of submerged jets discharging horizontally and vertically into a reservoir using various salt and fresh water combinations. A small conductivity probe has been designed to measure and record salinity diffusion in the jet. Comparisons of mass and momentum diffusion for water and gaseous jets have been made.

(2545) MODEL STUDY OF WAVE PROTECTION FOR NARRAGANSETT BAY NAVAL FACILITIES.

(b) District Public Works Office, First Naval District, Boston.
(c) Prof. P. S. Eagleson, Hydrodynamics Lab., Mass. Inst. of Tech., Cambridge 39, Mass.

(d) Experimental; design.
(e) Model to determine size and location of breakwater to provide optimum protection from wave action for berthing facilities.
(f) Completed.
(g) A distorted scale (1:400 horizontal, 1:120 vertical) model encompassing approximately 3.5 sq. prototype miles was tested with selected waves generated by a 20 foot long, movable, plunger type wave generator having continuously variable speed and stroke. Mean ebb and flood tidal currents were reproduced by circulation of water through the basin.
The optimum breakwater size and location were determined.
(h) "Hydraulic Model Study of Protective Works for Fleet Berthing Facilities in Narragansett Bay, R. I.", F. J. Turpin, M. Sc. Thesis, 1957.
"Hydraulic Model Study of Protective Works for Fleet Berthing Facilities in Coddington Cove, Naragansett Bay, R. I.", P. S. Eagleson, T. A. Marlow, C. T. Luke, F. J. Turpin, Technical Report No. 25, Hydrodynamics Laboratory, MIT, 1957.

(2546) CHARACTERISTICS OF FLOW WITH DILUTE FIBER SUSPENSIONS.

(b) Technical Association of Pulp and Paper Industries.
(c) Prof. J. W. Daily, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental and analytical; basic research.
(e) Basic investigation of the hydrodynamic features of paper fiber suspensions.
(g) Following a survey of existing knowledge of the fluid mechanics of the flow of fiber suspensions as related to the flow in paper making machines, an experimental program was initiated for investigating the hydrodynamic characteristics of fiber suspensions in fully developed shear flows and in non-shear fields for both the laminar and turbulent ranges.
(h) "Pertinent Factors in Flow Research on Dilute Fiber Suspensions", by A. T. Ippen, J. W. Daily, and G. Bugliarello. TAPPI Vol. 40, No. 6, June 1957.

(2547) CHARACTERISTICS OF THE CIRCULAR HYDRAULIC JUMP.

(b) Laboratory project.
(d) Theoretical and experimental; graduate theses.
(e) A study of the characteristics of the circular hydraulic jump which is formed by axially symmetrical supercritical flow from a source or to a sink.
(g) A lucite water table has been constructed to obtain supercritical flows issuing radially outward from a source or directed inward toward a sink. By proper control of tailwater hydraulic jumps circular in plan view are created. Measurements of depths and velocities are being made for comparison with the momentum equations for the two types of jumps described above.

(2548) MECHANICS OF WASTE WATER DIFFUSION.

(b) U. S. Public Health Service.
(d) Theoretical and experimental; basic research.
(e) An investigation of various turbulent diffusion processes for application to waste disposal in streams, lakes and oceans.
(g) Experimental facilities have been constructed to study the diffusion of salt concentration in a one-dimensional field of uniform turbulence. Turbulence is created mechanically in a body of water contained in a 32 foot long channel by means of a stack of expanded aluminum sheets oscillating vertically with amplitudes up to one inch and frequencies up to six cycles per second.
Concentrations versus time are measured and recorded electrically at various stations by means of probes sensitive to the changes in resistivity of the saline solution. Initially experiments were made to determine: rate of energy dissipation, longitudinal and vertical turbulent diffusion coefficients, as a function of amplitude and frequency of oscillation. Subsequent experiments will simulate the mixing process which occurs in an estuary under conditions of varied rates of fresh water inflow and of salt water entrainment.

(2549) SURGE TANK MODEL STUDIES.

(b) Laboratory project.
(c) Prof. D. R. F. Harleman, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental; graduate and undergraduate theses.
(e) General investigations on the validity of the hydraulic analog model for the solution of the differential equations for surge tanks.
(f) Completed.
(g) A hydraulic analog model surge tank system has been used to reproduce a wide range of prototype operating conditions. Investigations have been made on both simple and restricted orifice surge tank systems. Comparison of model results with graphical and analytical solutions shows good agreement.

(2801) INTERACTION OF WAVES WITH FLOATING BODIES.

(b) Office of Naval Research, Dept. of the Navy.
(c) Prof. A. T. Ippen, Prof. F. Ursell, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Theoretical and experimental; basic research.
(e) Analytical and experimental study of the interaction of floating bodies and waves. Results to be applied to development of movable breakwaters for shallow and deep water waves.

(g) Initial studies are concerned with experimental verification of wave-maker theory and a precise determination of the reflection characteristics of the 100-foot wave tank used in this program.

(2802) EXPERIMENTAL STUDY OF WAKE MECHANICS.

(b) Office of Naval Research, David Taylor Model Basin, Dept. of the Navy.
(c) Prof. A. T. Ippen, Prof. P. S. Eagleson, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental; basic research.
(e) Definition of flow conditions immediately downstream of a thin flat plate with special emphasis on vortex shedding in relation to transverse plate vibration.
(g) Construction of an open circuit water tunnel with 7-1/2 by 9 inch closed jet test section is currently under way.

(2803) PROXIMITY EFFECTS ON DRAG COEFFICIENTS.

(b) Laboratory project.
(c) Prof. R. E. Nece, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental; undergraduate theses.
(e) Study of resistance of submerged objects due to variations of geometry of group spacing.
(g) Drag coefficients for the center one of three equally spaced circular cylinders aligned normal to the free stream velocity were determined at a Reynolds number of 2×10^4 for a range of lateral spacings. Tests were performed in a free surface water channel. Experimental procedures check the drag coefficient of a single cylinder in an infinite fluid.

(2804) FLOOD FREQUENCY STUDIES.

(b) Laboratory project.
(c) Prof. G. R. Williams, Hydrodynamics Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Analytical; graduate theses.
(e) Investigation of theory that the complete series of annual flood peaks in a record may represent sampling from more than one statistical population and that the flood frequency relation may be best represented by more than one curve.
(g) The results of this type of study for a number of river basins in the North Eastern states confirmed the theory for some rivers. Further investigations are contemplated.
(h) "Flood Frequency Studies", by L. Franceschi-Ayala, M. Sc. Thesis, 1957.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Department of Mechanical Engineering.

(880) RECOVERY FACTORS AND HEAT-TRANSFER COEFFICIENTS FOR SUPERSONIC FLOW OF AIR IN A TUBE.

(b) Office of Naval Research, Department of the Navy.
(c) Prof. Joseph Kaye, Mech. Engineering Dept., MIT, Cambridge 39, Mass.
(d) Experimental and theoretical; basic research for M.S. and Sc. D. degrees.
(e) The project objectives are to measure reliable heat-transfer coefficients for supersonic flow of air in a tube to study characteristics of such flow by investigation of the fundamental differential equations, and to measure boundary layer characteristics such as velocity and temperature profiles for such flows.
(f) Completed Sept. 30, 1957.
(g) The publications now being written will summarize results obtained.

(1884) EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF CYCLONE DUST SEPARATOR.

(b) Laboratory project.
(c) Prof. J. H. Keenan, Room 3-254, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical applied research.
(e) Observation of patterns of flow by means of velocity and direction probes. Variation in radial flow distribution is being observed for a range of ratio of inlet area to cylinder cross-sectional area. Analytical studies are in progress to explain the observed effects.
(g) Variation in radial flow distribution.
(h) Master's Thesis by Rodney Shuart and R. J. Salter; Doctor's Thesis by Helmut Weber. "Head Loss in Flow Through a Cyclone Dust Separator or Vortex Chamber", by Weber and Keenan, ASME Paper No. 56-A-8.

(1901) THREE-DIMENSIONAL TURBULENT BOUNDARY LAYER IN A VANELESS DIFFUSER.

(b) Gas Turbine Laboratory.
(c) Mr. Ernest B. Gardow, Gas Turbine Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Experimental and theoretical.
(e) Study of three dimensional boundary profiles and vaneless diffuser performance.
(g) Boundary layer has been studied in detail over range of inlet swirl angle of practical interest.

(1903) STALL PROPAGATION IN AXIAL COMPRESSORS.

(b) National Advisory Committee for Aeronautics.
(c) Prof. Alan H. Stenning, Mech. Engineering Dept., Mass. Inst. of Technology, Cambridge 39, Mass.
(d) Theoretical and experimental fundamental investigation of the phenomenon of stall propagation in cascades and compressors.
(e) An investigation of the phenomenon of rotating stall in axial compressors, and unsteady flow effect which has been responsible for many structural failures in gas turbine engines. Experimental study is being made with a circular cascade and a single stage compressor.

(f) Completed.

(g) A good understanding of the mechanism of stall propagation was obtained, with fair correlation between theoretical and experimental propagation velocities. No explanation for the varying size of stall cells has been found.

(h) "Stall Propagation in a Cascade of Airfoils" by A. H. Stenning and A. R. Kriebel, ASME preprint 57-SA29.

(2344) ATOMIZATION STUDY.

(b) Laboratory project.

(c) Prof. K. R. Wadleigh, Mech. Engineering Dept., MIT, Cambridge 39, Mass.

(d) Experimental and theoretical; applied research, mostly S.M. and Sc.D. theses.

(e) Study of the atomization of liquid streams injected into high-velocity gas streams. Simplified theoretical models of the various phenomena are used to guide experimental programs. Considerable instrument development has been necessary.

(g) A theoretical study of the dynamics of break-up of a large liquid droplet in a gas stream predicts that such break-up will occur at a critical value of the Weber number. Experimental verification has been achieved.

A photometric device for measurement of mean droplet size in high velocity gas streams has been developed.

(2550) BOUNDARY LAYER IN A CORNER AT THE JUNCTION OF TWO PERPENDICULAR WALLS.

(b) Laboratory project.

(c) Prof. A. H. Shapiro, Room 3-264, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Theoretical and experimental; basic research for doctoral degree.

(e) The interference of two boundary layers such as occurs near the corner of a rectangular duct is being investigated experimentally and theoretically. Important aspects of the investigation include: (1) Growth of laminar boundary layer, effect of pressure gradient; (2) growth of turbulent layer, effect of pressure gradient, examination of secondary flows; (3) separation in adverse pressure gradient; and (4) Transition from laminar to turbulent flow.

(g) A theory for the laminar layer now nearly complete. Experimental results for the laminar layer being collected.

(2552) TWO-PHASE FLOW STUDIES IN PIPES.

(b) Babcock and Wilcox Co., Alliance, Ohio.

(c) Prof. M. A. Santalo, Mass. Inst. of Technology, Room 3-164, Cambridge 39, Mass.

(d) Experimental and theoretical; one doctor's thesis, two master's and several bachelor's.

(e) Study of the basic mechanism of the simultaneous flow of two phases in a vertical pipe. An experimental apparatus uses Freon-12 as working fluid and permits measurement of pressure drop in a vertical test section with and without boiling. A

preheater enables a varying inlet quality from subcool to saturated vapor. The ultimate goal is an understanding of flow distribution and stability in parallel circuits.

(h) "Study of Two-Phase Flow in Pipe Bends", J. R. Castillo, S.M. Thesis, June 1957. "An Investigation of Two-Phase Two-Component Flow in Bends", M. I. Cohen, B. S. Thesis, June 1957.

(2554) FLOW OF FLUIDIZED SOLIDS

(b) M. W. Kellogg Company, New York City.

(c) Prof. K. R. Wadleigh, Mass. Inst. of Technology, Room 3-166, Cambridge 39, Mass.

(d) Experimental and theoretical; one doctor's thesis, several master's and bachelor's.

(e) Study of the characteristics of the down-flow of fluidized solids near the packing regime. The major experimental apparatus permits pressure drop measurements and control of flow regimes.

(f) Discontinued.

(g) A criteria for packing or fluidization of solids once end effects are known.

(h) "A Batch-Flow Apparatus for the Investigation of Dense-Phase Down-Flow of Fluidized Solids", S. Yamamoto, S.M. Thesis, MIT, June 1957.

(2560) UNSTEADY-STATE CONVECTIVE HEAT TRANSFER PROCESSES.

(b) Wright Air Development Command, USAF.

(c) Prof. R.J. Nickerson, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Experimental and theoretical; basic research.

(e) The effect of oscillations on the forced convective heat transfer from a body is being investigated. Thus far, oscillations of a plate parallel to a stream and oscillations of a cylinder in cross-flow in directions parallel and perpendicular to the stream have been investigated.

(g) The results for flat plate oscillations parallel to the main stream are summarized in a WADC Technical Report to be submitted in the near future. No significant effects on the steady rate of heat transfer from the plate were noted.

(h) Progress reports have been submitted to WADC. Summary technical reports are in preparation.

(2805) UNSTEADY BOUNDARY LAYER.

(c) Mr. Philip A. Hill, Research Assistant, Gas Turbine Laboratory, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Experimental study of a laminar boundary layer in a streamwise-constant pressure gradient when the main stream velocity fluctuates harmonically; for doctoral thesis.

(2806) GEAR PUMP STUDY.

(b) Chandler Evans Co.

(c) Prof. K. R. Wadleigh, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Experimental and theoretical, applied research and design.

(e) Study of the performance characteristics and losses in aircraft gear pumps to permit optimization of designs for specific performance requirements.

(g) Predictions of mechanical friction losses and fluid leakage losses agree well with experimental data.

(2807) UNSTEADY TWO-DIMENSIONAL FLOW IN A PARTIAL ADMISSION TURBINE.

(b) U. S. Underwater Ordnance Station, Newport, Rhode Island.

(c) Prof. Robert W. Mann, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Theoretical and experimental investigation; applied research for doctoral and master's theses.

(e) In a partial admission turbine as rotor channels filled with relatively stagnant fluid enter the active nozzle jet the fluid in the rotor channels wants to be accelerated. If the active nozzle jet to blade spacing ratio is large enough, steady-state velocities will be achieved in the rotor blading after which a deceleration of the fluid in the rotor passages occurs as the rotor passage moves out of the nozzle jet. The substantial contributor to the low efficiency of the partial admission turbine is this acceleration-deceleration problem. The purpose of this project is to develop an understanding of this flow by theoretical and experimental means in order to develop design criterion which will permit an improvement in turbine performance. The experimental work will include the use of hydraulic analogy for supersonic flow and/or high speed interferometric and Schlieren photography.

(2808) INTERACTION OF LINE VORTICES.

(c) Prof. A. H. Shapiro, Room 3-264, Mass. Inst. of Technology, Cambridge 39, Mass.

(d) Theoretical and experimental; basic research.

(e) Interaction of several line vortices, with emphasis on whether the mutually-induced motions tend to increase or decrease the spatial concentration of vorticity.

UNIVERSITY OF MASSACHUSETTS, Department of Civil Engineering.

(2561) HYDROLOGIC STUDIES IN WESTERN MASSACHUSETTS.

(b) Cooperative with Soil Conservation Service, U.S. Weather Bureau, U.S. Geological Survey.

(c) Dean George A. Marston, Director, Engrg. Research Institute, Univ. of Mass.,Amherst, Mass.

(d) Experimental; field and laboratory; for design of Watershed protection, Flood Peak

Reduction projects and general information.

(e) Rainfall and runoff studies will be made on small drainage areas which when combined with other hydrologic factors such as temperature, vegetal cover, ground water, etc., will provide a better basis for design of small reservoirs whose chief purpose is reduction of flood peaks.

(g) Project in initial stages.

UNIVERSITY OF MICHIGAN, Department of Civil Engrg.

(2129) DEVELOPMENT OF OPEN CHANNEL FLOW CONTROL.

(b) Rackham Research Grant.

(c) Prof. V. L. Streeter, University of Mich., 322 W. Engineering Bldg., Ann Arbor, Mich.

(d) Experimental and analytical.

(e) Determination of effectiveness of the principle of single-orifice flow control with a non-linear spring resistance as applied to open channels.

(f) Completed.

(g) The general principle of a spring force varying exponentially with displacement and an orifice area varying exponentially with spring displacement yielding substantially constant flow control over the design head range has been confirmed.

(2562) MODEL TEST OF BOOSTER PUMPING STATION FOR WATER WORKS PARK, DETROIT, MICHIGAN.

(b) Detroit Board of Water Commissioners.

(c) Prof. V. L. Streeter, University of Mich., 322 W. Engineering Bldg., Ann Arbor, Mich.

(d) Experimental.

(e) A plexiglas scale model (1:21) of a pumping station includes complete hydraulic system within caisson except pump vanes, for four 66-inch diameter vertical shaft axial-flow pumps.

(f) Completed.

(g) By installation of turning vanes before the pump pit and baffles within the pump pit the overall hydraulic losses through the pump were reduced by 50% and flow conditions improved in the pump pit.

(h) University of Michigan Engineering Research Institute Report, April 1957.

(2564) DETERMINATION OF MAXIMUM FLOODS ON ROUGE RIVER.

(b) Wayne County Road Commission.

(c) Prof. E. F. Brater, University of Michigan, 320 W. Engineering Bldg., Ann Arbor, Mich.

(d) Analytical.

(e) To determine infiltration capacities and unit hydrographs for the Rouge River basin for the purpose of determining the magnitude of future floods and the effectiveness of various methods of reducing flood stages.

(f) Completed.

(g) The project was completed. An improved

method of predicting flood frequency was developed.

    (h) Report published by sponsor.

(2809) ELIMINATION OF WAVE MOTION IN MENTOR HARBOR, OHIO.

    (b) The Mentor Harbor Yachting Club.
    (c) Prof. E. F. Brater, University of Michigan, 320 W. Engineering Bldg., Ann Arbor, Mich.
    (d) Model study.
    (e) A 1:50 model of the harbor area was constructed. Prototype wave conditions were reproduced in the model and methods of eliminating the objectionable conditions are being tested.

UNIVERSITY OF MICHIGAN, Ship Model Tank.

Inquiries should be addressed to Prof. R. B. Couch, Chairman, Dept. of Naval Architecture and Marine Engineering, 450 West Engineering Bldg., University of Michigan, Ann Arbor, Mich.

(1378) VIBRATION ELIMINATION.

    (b) Laboratory and field projects.
    (c) Prof. L. A. Baier, (ret.) 324 West Eng. Bldg., Univ. of Michigan, Ann Arbor, Mich.
    (d) Experimental; applied research.
    (e) Design and testing of vertical and horizontal flow control fins fitted to both single and multiple screw hulls in way of propeller in order to control feed water flow and eliminate fantail vibration. Recent emphasis placed on triple screw stern vibration in river towboats.

(2349) OIL BARGE DESIGN.

    (b) Union Industrial of Astilleros Barranquilla, Colombia.
    (c) Prof. L. A. Baier, (ret.) 324 West Eng. Bldg., Univ. of Michigan, Ann Arbor, Mich.
    (d) Experimental.
    (e) Determination of best barge form for flotilla operation under local conditions.
    (f) 75% completed.

(2810) VESSEL STABILITY.

    (b) U.S. Steel Corp., Monroeville, Pa.
    (c) Prof. L. A. Baier, (ret.) 324 West Eng. Bldg., Univ. of Michigan, Ann Arbor, Mich.
    (d) Experimental.
    (e) Effect of and changes in loading iron ore concentrates in Great Lakes vessels.
    (f) 50% completed.

(2811) TURBULENCE STIMULATION ON SHIP MODELS.

    (b) Laboratory project.
    (c) Prof. R. B. Couch, Dept. of Naval Architecture and Marine Engrg., 450 West Eng. Bldg., Univ. of Michigan, Ann Arbor, Mich.
    (d) Experimental and applied research.
    (e) Testing of various turbulence stimulating devices, such as girth wires and studs on

ship models of different sizes and fullnesses to establish optimum techniques for use in the ship model tank.

UNIVERSITY OF MINNESOTA, Agricultural Experiment Station.

(1929) DRAIN TILE JUNCTION LOSSES.

    Cooperative with St. Anthony Falls Hydraulic Laboratory. See Page No. 63.

(2350) DRAINAGE OF AGRICULTURAL LAND BY PUMPING.

    (b) Laboratory project.
    (c) Prof. Curtis L. Larson, Dept. of Agricultural Engineering, University of Minn., St. Paul 1, Minnesota.
    (d) Theoretical and field investigations; applied research.
    (e) The project has three phases: (1) The development of basic relations for planning pump drainage systems, (2) the study of rates of drainage, and (3) the study of factors affecting the efficiency.
    (g) Expressions for the amount of storage required by automatic and non-automatic pumping plants have been developed. A new device for measuring effluent from partially filled pipes was developed in laboratory tests.
    (h) "Planning Pump Drainage Outlets", Curtis L. Larson and Evan R. Allred. Agricultural Engineering, Vol. 37, No. 1, pp. 38-40, Jan. 1956.
        "Tests of New Device for Measuring Pipe Effluent", Curtis L. Larson and Lee F. Hermsmeier. Agricultural Engineering (publication pending).

(2576) CONSTRUCTION, DEVELOPMENT, AND PUMPING OF SHALLOW WELLS FOR IRRIGATION.

    (b) Field project.
    (c) Prof. Evan R. Allred, Dept. of Agricultural Engrg., Univ. of Minnesota, St. Paul 1, Minn.
    (d) Field investigation; applied research and development.
    (e) The objectives of the project are: (1) To study and develop inexpensive methods for construction of shallow irrigation wells, (2) determine hydraulic permeability and characteristics of various aquifers, and (3) to survey and determine extent and availability of shallow ground water sources for irrigation in Minnesota.

MISSOURI SCHOOL OF MINES AND METALLURGY, Department of Civil Engineering.

(317) VELOCITY STUDIES IN A VERTICAL PIPE FLOWING FULL.

    (b) Laboratory project.

(c) Prof. Clifford D. Muir, Civil Engineering Dept., Missouri School of Mines and Metallurgy, Rolla, Mo.

(d) Experimental; basic research for master's thesis.

(e) Tests were conducted on vertical flow in 1/2-inch hard-drawn copper pipe to investigate flow with pipe flowing full and under positive pressure.

(g) The experimental results obtained were in agreement with theoretical computations. Continuing studies confirm the previous results.

(319) WEIR STUDIES.

(b) Laboratory project.

(c) Prof. E. W. Carlton, Civil Engineering Dept., Missouri School of Mines and Metallurgy, Rolla, Mo.

(d) Experimental; basic research for master's thesis.

(e) Tests on rectangular weirs were made to determine effect of velocity of approach on the relation between crest depth and critical depth of an imaginary open channel having same dimensions as the weir opening.

(g) Study produced a simple, accurate and quick solution for plotting of M function. Relationship between the M function and the critical depth is logarithmic. This greatly simplifies determination of critical flow where the critical depth is known or vice versa. A relationship exists between M function of channels of same shape but different dimensions. The velocity of approach does not affect the relationship between physical depth and crest depth.

(2578) CORRELATION OF WEIR CREST DEPTH AND WEIR FLOW CHARACTERISTICS.

(b) Laboratory project.

(c) Prof. Clifford D. Muir, Civil Engineering Dept., Missouri School of Mines and Metallurgy, Rolla, Mo.

(d) Experimental.

(e) Tests on several cipoletti weirs were made in order to determine the effect of weir thickness, H/P ratio, and Froude's number on the ratio of crest depths to the critical depth of an imaginary open channel having the same dimensions as the weir flow section.

(g) This study indicated a definite relationship between the crest depth to critical depth ratio and the Froude number of the imaginary channel. However, the ratio tended to become constant at either high or low Froude numbers. The H/P ratio had no noticeable effect on this relationship. A continuation of this study indicates the probable superiority of crest depth flow relationships when weirs having a narrow width with respect to head are being used.

UNIVERSITY OF MISSOURI, Engineering Experiment Station.

(2134) HEAD LOSSES IN STORM DRAIN JUNCTION BOXES.

(b) Missouri State Highway Department in cooperation with U. S. Bureau of Public Roads.

(c) Prof. Horace W. Wood, 150 Engineering Bldg., University of Missouri, Columbia, Mo.

(d) Experimental and analytical; applied research, development.

(e) Model study of inlet junction boxes and manholes for use in urban highway design; determination of coefficients by which pressure changes at junctions can be accurately anticipated for various common configurations; preparation of design charts and instructions for their use.

(f) Experimental work completed; final report with design material in preparation.

(g) The design section, which will be published under separate binding, will enable designer to determine the pressure change occurring at open junctions when the pipes are flowing full and the liability of overflow is a consideration.

(h) "Progress Report on Investigation of Head Losses at Junctions in Storm Drains" presented by William M. Sangster at January 1957 meeting of the Highway Research Board.

MONTANA STATE COLLEGE, Agricultural Experiment Station.

Inquiries concerning Projects Nos. 2579 and 2580 should be addressed to Mr. O. W. Monson, Head, Agricultural Engineering Dept., Montana State College, Bozeman, Mont.

(2579) STREAM FLOW FORECASTING BASED ON SNOW SURVEYS.

(b) Cooperative with Soil and Water Conservation Research Branch, Agricultural Research Service.

(d) Experimental; to improve methods of forecasting stream flow and seasonal runoff for irrigation, power, flood control and other uses.

(e) A network of snow survey courses has been established on all the principal watersheds of Montana. Snow measurements are made at these points during the winter and spring months. The water equivalent of the snow is correlated with subsequent runoff from the watershed. Provisional forecasts are published as early as March of each year. Final forecasts are amended as necessary in April and May.

(g) Statistical treatment of data directed towards the possibility of making 10-day forecasts of natural stream flow available for diversion for irrigation. Some progress noted. Studies confined to West Gallatin River at Gateway.

(h) Published forecasts are sent to a selected list of agencies, libraries, and water users.

(2580) EFFICIENT APPLICATION OF IRRIGATION WATER.

(b) Cooperative with the U. S. Bureau of Reclamation.

(d) Experimental and field investigations.

(e) This study is an attempt to correlate the size of irrigation stream with the rate of infiltration of the soil and the length of run and the slope of field.

(g) Field tests to show practical application of equation giving Q in (cfs) as related to "l" infiltration; "S" slope or gradient of field; "W" width of strip, ft.; "L" length of strip, ft.; and "γ" a coefficient corresponding to Horton's "γ". Field tests gave promising results. More detailed work needed.

(h) Annual reports prepared for cooperating agencies. No published reports.

NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY.

Inquiries concerning Projects Nos. 123, 124, 896, 901, 1132, 1133, 1136, and 2582 should be addressed to Mr. C. H. Hancock, Hydraulic Laboratory, Newport News Shipbuilding and Dry Dock Company, Newport News, Virginia.

(123) HYDRAULIC TURBINE TESTS.

(b) Laboratory project.

(d) Experimental; for design data.

(e) Scale model turbines, using either Francis or propeller type runners, are tested for power and efficiency at various speeds.

(124) METER CALIBRATION TESTS.

(b) Laboratory project.

(d) Experimental.

(e) To establish calibration curve for determining correction for various rates of flow. Meters are tested at various rates of flow by weighing tank method. Time is recorded electronically by decade counters.

(896) VANE MOMENT TESTS ON ADJUSTABLE BLADE RUNNERS.

(b) Laboratory project.

(d) Experimental; for design data.

(e) Tests are to determine vane moment diagrams. The turbine load is applied by an electrical dynamometer and the gate openings are controlled by a governor. The blades adjust automatically and the blade moment is measured by a spring dynamometer.

(901) SHIP MODEL RESISTANCE TESTS.

(b) Laboratory project.

(d) Experimental; for design data.

(e) Scale ship models are towed to determine the effective horsepower, bare hull, required by the ship. Because of their small size, several models may be towed in a short period of time thus allowing much preliminary work to be done on the choice of lines. The final lines are checked by the David Taylor Model Basin. To eliminate a large portion of this preliminary testing, a schedule of systematic models was arranged in which the beam-draft ratio, the displacement-length ratio, and the prismatic coefficient are varied over a wide range. Towing this set of models is continuing and when completed will provide design data for a standard offset series covering a wide range.

(1132) HYDRAULIC PUMP TESTS.

(b) Laboratory project.

(d) Experimental; for design data.

(e) Scale model pumps centrifugal and propeller types, are tested at constant speeds for head developed, power consumption, and efficiency at various rates of discharge. Cavitation tests are sometimes conducted by lowering the suction head to a point where the developed head and efficiency break down.

(1133) CAVITATION TESTS OF HYDRAULIC TURBINE MODELS.

(b) Laboratory project.

(d) Experimental; for design data.

(e) Scale model turbines are tested on cavitation stand to determine sigma at which cavitation starts. By the use of a Plexiglas throat ring and a Strobolux light synchronized with the shaft rotation, visual observations are made to determine the location on the blade where cavitation starts. Tests also run to determine runaway speeds at low sigma values.

(1136) WAVE TESTS ON SHIP MODELS.

(b) Laboratory project.

(d) Experimental; for design data.

(e) Ship models are tested with scaled waves to determine speed reduction in waves for the pull required for various still water speeds. Pitching periods and angles are determined from light trace photographs. Wave tests were conducted for the ICSH Seaworthiness Committee and the results were reported at the Seventh International Conference on Ship Hydrodynamics in Scandinavia in August 1954. These tests were made on a Todd-Forrest Series 60, Block 0.60 model, at three radii of gyration, at five towline pulls, in four wave lengths of a single wave height. Wave tests are being made in conjunction with the ATTC Seaworthiness Committee program.

(2582) AIR TESTS ON HYDRAULIC TURBINE MODEL.

(b) Laboratory project.

(d) Experimental; for design data.

(e) Plexiglas hydraulic turbine model is tested with air. Smoke and tufts are used in the flow visualization studies. Velocity and pressure distribution studies are made using a sensitive differential manometer. The gate moments obtained from the pressure distribution will be checked with a strain

gage dynamometer.

NEW YORK UNIVERSITY, Department of Chemical Engrg.

Inquiries concerning Projects Nos. 2135, 2583, 2584, and 2812, should be addressed to Prof. John Happel, Dept. of Chemical Engineering, New York University, University Heights, New York 53, N. Y.

(2135) EFFECT OF A CYLINDRICAL BOUNDARY ON STEADY VISCOUS FLOW PAST SINGLE SPHERES.

(b) Grant from Texas Company; laboratory project.
(d) Experimental; basic research for doctoral thesis.
(e) A study of the effect of a cylindrical boundary on steady flow past spheres as a function of Reynolds number, sphere-to-cylinder diameter ratio and distance of sphere from cylinder axis by measurement of drag on spheres and pressure drop caused by their presence.
(g) Experimental pressure drop and drag measurements in "creeping motion" indicate very good agreement with existing theoretical treatments, however at high Reynolds number marked deviations occur.

(2583) EFFECT OF PARTICLE CONCENTRATION ON PRESSURE DROP AND SEDIMENTATION VELOCITY IN DILUTE BEDS OF PARTICLES.

(b) Grant from Texas Company; laboratory project.
(d) Theoretical; basic research for doctoral thesis.
(e) The slow translational motion of dilute beds of particles settling through a viscous fluid subjected to the influence of spherical and cylindrical boundaries is being studied. This will ultimately enable a theoretical prediction of the effect of particle concentration on pressure drop and sedimentation velocity in beds of particles.
(g) The velocity field created by the settling of a single spherical particle at an arbitrary location within a spherical container has been solved by the "method of reflections." The field is expressed as a convergent series of solid spherical harmonics.

(2584) AN EXPERIMENTAL STUDY OF THE SLOW MOTION OF TWO SPHERES IN A VISCOUS FLUID.

(b) Grant from the American Petroleum Research Fund of the American Chemical Society; laboratory project.
(d) Experimental; basic research for master's thesis.
(e) Determination of the terminal settling velocity of two equal size spheres moving (1) parallel to their line of centers, and (2) perpendicular to their line of centers as a function of ratio of sphere diameter to center-to-center distance, and Reynolds

number. An attempt to verify existing theoretical solutions of this problem for the case of "creeping motion" as well as a determination of the upper Reynolds number limit beyond which the theoretical treatment becomes invalid.
(g) Trial experiments for settling of two spheres parallel to their line of centers show that total drag diminishes as the distance between spheres is decreased.

(2812) EFFECT OF AN AXIALLY LOCATED SPHERE ON THE PRESSURE DROP OF A VISCOUS FLUID FLOWING THROUGH A CYLINDRICAL TUBE.

(b) Grant from the American Petroleum Research Fund of the American Chemical Society; laboratory project.
(d) Theoretical and experimental; basic research for master's thesis.
(e) Theoretical analysis of the pressure at all distances from a single sphere located at the axis of a cylindrical tube through which a viscous fluid is flowing. The expression for pressure so obtained will be experimentally verified in the laboratory.

NEW YORK UNIVERSITY, Fluid Mechanics Laboratory.

(1912) DISCHARGE CHARACTERISTICS OF A SIDE WEIR.

(b) Laboratory project.
(c) Prof. A. H. Griswold, New York University, New York 53, N. Y.
(d) This is an applied research project in which a theoretical analysis is being checked experimentally.
(g) A test program has been completed that included tests of two widths of channel, two lengths of crest and two crest heights. The analysis of this data is underway.

NEW YORK UNIVERSITY, Department of Meteorology and Oceanography.

(2354) INTERACTION BETWEEN OCEAN AND ATMOSPHERE WITH SPECIAL REFERENCE TO THE HYDRAULIC CIRCULATION.

(b) Geophysics Branch, Office of Naval Research, Department of the Navy.
(c) Dr. Gerhard Neumann, Professor of Oceanography, New York University, College of Engineering, New York 53, N. Y.
(d) Theoretical research including evaluation of oceanographic observations.
(e) The aim of the project is to study the interrelationships between the atmosphere and the oceans with special consideration of the wind driven oceanic circulation and the stratification of the water masses.
(f) Completed.
(g) The horizontal circulation of wind-driven

ocean currents was examined by taking into account the average vertical density stratification and the spherical shape of the earth. The variable depth of the lower boundary of the wind-driven circulation plays an important role in the hydrodynamic analysis of the circulation system. A numerical solution was given for the horizontal mass transport in the North Atlantic Ocean, and a theoretical study deals with a three-dimensional model of wind generated currents in a stratified ocean. The analysis of the dynamical structure of the Gulf Stream and its mass distribution indicates that the current system approaches equivalent barotropic conditions.

(h) "Wind Stress on Water Surfaces", G. Neumann, Bull. of the Amer. Meteor. Soc., Vol. 37, No. 5, pp. 211-217, May 1956.
"Notes on the Horizontal Circulation of Ocean Currents", G. Neumann, Bull. of the Amer. Meteor. Soc., Vol. 37, No. 3, pp. 96-100, March 1956.
"Zum Problem der "Dynamischen Bezugsfläche", insbesondere im Golfstromgebiet", G. Neumann, Deutsche Hydr. Zeitschr., Vol. 9, No. 2, 1956, pp. 66-78.
"Contributions to the Study of the Oceanic Circulation", New York University, College of Engineering, Research Division, Contract Nonr 285(12), Office of Naval Research: G. Neumann and F. Ostapoff, The mean water transport by wind driven ocean currents in the North Atlantic for the month of February; F. Ostapoff, On the depth of the layer of no motion in the Central Pacific Ocean; El Sayed M. Hassan, On the ocean circulation. Preliminary distribution, September, 1957.

(2355) OFFICE OF NAVAL RESEARCH WAVE PROJECT.

(b) Geophysics Branch, Office of Naval Research, Department of the Navy.
(c) Prof. Willard J. Pierson, Jr., Research Associate Professor of Meteorology, New York University, University Heights, New York 53, New York.
(d) Experimental and theoretical; basic and applied research.
(e) Study of the generation and propagation of waves in deep water; of wave observation and forecasting techniques and of waves as a three variable stationary Gaussian process; digital analysis of stereo aerial wave photographs to determine the two dimensional spectrum of the waves as a function of wave frequency and direction. A study of the capillary wave spectrum is partially completed.
(g) Information on the spectrum of waves as a function of frequency and direction has been obtained. A study of swell records obtained by J. E. Dinger at N.R.L. at Barbados is under way. Further work on Project 2354 will be combined with this project for the coming year.
(h) "The Directional Spectrum of a Wind Generated Sea as Determined From Data

Obtained by the Stereo Wave Observation Project", by Joseph Chase, L. J. Cote, W. Marks, E. Mehr, W. J. Pierson, Jr., F. C. Rönne, G. Stephenson, R.C. Vetter, and R. G. Walden. Technical Report for the Office of Naval Research.
"A Comparison of Various Theoretical Wave Spectra", G. Neumann and W. J. Pierson, Jr. Proc. of the Symposium on the Behavior of Ships in a Seaway, Netherlands Ship Model Basin, Wageningen.
"A Detailed Comparison of Various Theoretical Wave Spectra and Wave Forecasting Methods", G. Neumann and W. J. Pierson, Jr. (To appear in Deutsche Hydrogr. Zeitschr.)

(2356) SHIP MOTIONS PROJECT.

(b) David Taylor Model Basin, Department of the Navy.
(c) Prof. Willard J. Pierson, Jr., Research Associate Professor of Meteorology, New York University, University Heights, New York 53, New York.
(d) Theoretical and experimental; basic and applied research.
(e) Studies of the theory of a stationary Gaussian process as applied to the motions of ships in waves; experimental and theoretical determination of co-spectra and quadrature spectra.
(g) Theoretical studies of cross spectra, and theoretical papers on wave theory and ship motion theory.
(h) "On the Joint Estimation of the Spectra, Co-Spectra and Quadrature Spectrum of a Two-Dimensional Stationary Gaussian Process", by N. R. Goodman. Technical Report No. 8, prepared for David Taylor Model Basin.
"Some New Developments in Probabilistic and Statistical Methods Applied to the Study of Ship Motion", by L. J. Tick and W. J. Pierson, Jr. Proc. of the Symposium on the Behavior of Ships in a Seaway, Netherlands Ship Model Basin, Wageningen.
"On the Phases of the Motions of Ships in Confused Seas", by W. J. Pierson, Jr. Technical Report No. 9, prepared for the David Taylor Model Basin.

(2357) WAVE PROJECT.

(b) Bureau of Ships, Department of the Navy.
(c) Prof. Willard J. Pierson, Jr., Research Associate Professor of Meteorology, New York University, University Heights, New York 53, New York.
(d) Theoretical and experimental, and basic and applied.
(e) Attempt to formulate the zero crossing problem of a stationary Gaussian process and solve it for spectra like those of ocean waves.
(g) Unpublished results which look quite promising have been obtained and the results will appear shortly.
(h) "On the Joint Estimation of the Spectra, Co-Spectra and Quadrature Spectrum of a

Two-Dimensional Stationary Gaussian Process", by N. R. Goodman, Technical Report prepared for the Bureau of Ships.

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING OF THE UNIVERSITY OF NORTH CAROLINA, Department of Engineering Research.

(593) DYNAMIC SIMILARITY OF SMALL HYDRAULIC MODELS.

(b) Laboratory project.
(c) Mr. N. W. Conner, Director of Engineering Research, North Carolina State College, Raleigh, N.C.
(d) Experimental and theoretical; basic research.
(e) An experimental determination and theoretical study of dynamic similarity of small hydraulic models by large scale ratios.
(f) Completed.

(1636) RAINFALL, INTENSITY, DURATION, FREQUENCY, CURVES FOR NORTH CAROLINA.

(b) Laboratory project.
(c) Prof. Charles Smallwood, Dept. of Civil Engineering, North Carolina State College, Raleigh, N. C.
(d) Experimental; basic and applied research.
(e) The collection and analysis of data pertaining to intensity, duration, and frequency of rainfall in North Carolina.
(g) Since work is continuing, no conclusive results are available at this time.

NORTHWESTERN UNIVERSITY, The Technological Institute.

(2137) SPRAY DROPLET FORMATION.

(b) Laboratory project, supported in part by Project SQUID, Princeton University.
(c) Prof. Wm. F. Stevens, Northwestern Univ., Evanston, Illinois.
(d) Experimental and theoretical investigation, involving basic research, in part for thesis work.
(e) In order to understand more completely the operation of a spray nozzle, information is being sought concerning the mechanism of spray formation. Drop-size distribution data are being obtained, using a new technique involving capture of the spray in liquid nitrogen.
(g) Project being continued. Results will be reported.
(h) Project SQUID Semi-Annual Progress Reports - October 1, 1956, April 1, 1957, and October 1, 1957.

(2361) FATE OF FISSION PRODUCTS IN SURFACE WATERS.

(b) U. S. Atomic Energy Commission.
(c) Prof. Carlos G. Bell, Jr., Northwestern University, Evanston, Ill.
(d) Theoretical and experimental; doctoral

research of Mr. Ivor Thomas.
(e) Study of the fate of fission products when injected into the Chicago Sanitary Ship Canal near Lemont, Ill.

(2585) MODEL STUDY ON SAVANNAH TIDAL ESTUARY.

(b) U. S. Atomic Energy Commission.
(c) Prof. Carlos G. Bell, Northwestern Univ., Evanston, Ill.
(d) Experimental, doctoral research.
(e) Study of feasibility of using a tidal model as an aid in the study of the fate of radioactive wastes in a tidal estuary.
(f) Completed.

(2586) DISPERSION OF FLUID IN POROUS MEDIA.

(b) Laboratory project.
(c) Prof. Robert B. Banks, Northwestern Univ., Evanston, Ill.
(d) Theoretical, experimental; doctoral thesis of Mr. Akio Ogata.
(e) Packed column apparatus permits sampling of fluid flow to determine effects of dispersion, diffusion and convection on the change in solute concentration.
(g) A theoretical analysis of the problem indicates that the phenomena is described by an equation similar to the heat conduction equation. Attempts are being made to correlate the dispersion coefficient in terms of a modified Reynolds number.

(2813) CAVITATION DAMAGE RELATED TO WAVE PATTERNS.

(b) Laboratory project.
(c) Prof. W. S. Hamilton, Northwestern Univ., Evanston, Ill.
(d) Theoretical and experimental; for master's thesis.
(e) Damage to samples of granular material placed near a collapsing cavity occurs in patterns that seem to depend on pressure-wave reflections. An attempt is being made to construct the wave patterns and relate them to the damage.
(g) Samples were tested in a piston-and-cylinder apparatus filled with water.

(2814) TORQUE CHARACTERISTICS OF A BUTTERFLY GATE.

(b) Laboratory project.
(c) Prof. W. S. Hamilton, Northwestern Univ., Evanston, Ill.
(d) Theoretical and experimental; for master's thesis.
(e) Torques on a sluice gate are to be computed from potential-flow patterns and compared with values measured in a model.
(g) Model has been tested and torque characteristic established for certain conditions.

(2815) LIQUID DROP ENTRAINMENT DUE TO CROSS-FLOW OF AIR.

(b) Laboratory project.
(c) Prof. W. S. Hamilton, Northwestern Univ., Evanston, Ill.

(d) Experimental; master's degree thesis for Mr. J. S. Millar.

(e) The features of tropical rainstorms have been analyzed and an apparatus to simulate such rainstorms in the laboratory has been constructed. Louvre angle may be varied to obtain variation of air-liquid entrainment ratio as function of blade angle.

(g) Particle trajectory, drop size distribution and liquid entrainment information has been obtained.

(2816) UNSTEADY FLOW ABOUT CYLINDERS AND SPHERES.

(b) Laboratory project.

(c) Prof. Robert B. Banks, Northwestern Univ., Evanston, Ill.

(d) Theoretical, experimental; master's degree research.

(e) An experimental apparatus is under construction which will allow determination of unsteady forces on submerged bodies. Velocities, accelerations and forces will be measured for flows around cylinders and spheres.

(f) Commencing.

(2817) UNSTEADY FLOW THROUGH EARTH DAMS.

(b) Laboratory project.

(c) Prof. Jorj O. Osterberg, Northwestern Univ., Evanston, Ill.

(d) Theoretical and experimental; doctoral research for Mr. William Fead.

(e) An analog model for the unsteady flow of liquid through earth dams has been constructed. Studies of sudden reservoir drawdown and filling have resulted in information on the development of seepage in earth dams.

(f) Completed.

(g) Experimental results compare favorably with relaxation method computations. Dimensionless plots of degree of drainage versus time factor have been obtained.

(2818) DIFFUSION IN TIDAL ESTUARIES.

(b) Laboratory project.

(c) Prof. Carlos G. Bell and Prof. Robert B. Banks, Northwestern University, Evanston, Ill.

(d) Theoretical and experimental; doctoral thesis of Mr. P. G. Huiswaard.

(e) Experimental work is being conducted in long, variable slope channel, modified to simulate a tidal estuary. Test results will be interpreted in the light of turbulent diffusion coefficients obtained by measurement of the longitudinal distribution of fluid tracers.

(2819) NON-NEWTONIAN FLUID FLOW IN PIPES.

(b) Laboratory project.

(c) Prof. Robert B. Banks, Northwestern Univ., Evanston, Ill.

(d) Theoretical; master's thesis for Mr. John Curtis.

(e) Analysis of existing data of flow of non-Newtonian fluids in pipes. Computation of friction factors and modified Reynolds numbers for laminar, transition and turbulent regions.

(2820) OBSERVATIONS IN TWO-DIMENSIONAL FLUIDIZED BEDS.

(b) Laboratory project.

(c) Prof. W. T. Brazelton, Northwestern Univ., Evanston, Ill.

(d) Experimental.

(e) Photographic study of an approximate two-dimensional bed to observe bubble growth factors and the onset of slugging.

(2821) PHYSICAL CHARACTERISTICS OF FLUIDIZED BEDS.

(b) Laboratory project.

(c) Prof. W. T. Brazelton, Northwestern Univ., Evanston, Ill.

(d) Experimental; doctoral thesis.

(e) Use of radiation absorption to determine density variations and describe particle motion and agglomerative tendencies. Physical characteristics as a function of bed position to correlate and explain heat and mass transfer.

(g) Bed densities from gamma ray absorptions available.

(2822) HEAT AND MASS TRANSFER IN FLUIDIZED BEDS.

(b) Laboratory project.

(c) Prof. W. T. Brazelton, Northwestern Univ., Evanston, Ill.

(d) Experimental, basic research.

(e) A study considering usual variables of particle size, gas rate, settled bed height but giving particular attention to parameter of bed position. Similar conditions are maintained for heat and mass transfer for comparative purposes.

(g) Effect of longitudinal position has been demonstrated for case of heat transfer. To test same for mass transfer.

(2823) HEAT TRANSFER IN THE FLOW OF GASES THROUGH GRANULAR BEDS.

(b) Laboratory project.

(c) Prof. George Thodos, Northwestern Univ., Evanston, Ill.

(d) Experimental, applied research; doctoral research for Mr. Yin-Chao Yen.

(e) Considerations are given for the better understanding and prediction of heat transfer coefficients involved in the flow of gases through granular packings. This work finds applicability in studies involving catalytic reactions. The effect of the geometry of the particles on heat transfer coefficients is being studied.

(g) Direct temperature measurements of gases and solids in bed made possible the direct calculation of the heat transfer coefficient for the gas film. Colburn heat transfer factor has been correlated to a modified Reynolds number.

(2824) RANQUE-HILSCH VORTEX TUBE.

(b) Laboratory project.
(c) Prof. G. M. Brown, Northwestern University, Evanston, Ill.
(d) Experimental, basic research; for doctoral thesis.
(e) Investigate flow pattern, pressure, temperature, velocity vector throughout vortex flow region. Explain resulting temperatures.
(h) "The Ranque-Hilsch Vortex Tube", William Alfred Scheller and George Martin Brown, Ind. Eng. Chem. 49, 1013-16 (1957).

(2825) SPRAY DROPLET VAPORIZATION.

(b) Laboratory project, supported in part by Project SQUID, Princeton University.
(c) Prof. Wm. F. Stevens, Northwestern Univ., Evanston, Ill.
(d) Experimental and theoretical investigation, involving basic research, in part for thesis work.
(e) As a prelude to the study of droplet combustion, droplet vaporization studies are being made. A mathematical model has been developed, and computer calculations are being carried on, leading to an understanding of the complex mass and heat transfer taking place.
(g) Project being continued. Results will be reported.
(h) Project SQUID Semi-Annual Progress Reports. AICHE Journal, 2, 555 (1956), Culverwell, et al.

UNIVERSITY OF NOTRE DAME, Department of Civil Engrg.

Inquiries concerning Projects Nos. 2826 and 2827 should be addressed to Dr. S. Kolupaila, Dept. of Civil Engineering, University of Notre Dame, Notre Dame, Ind.

(2826) PROPORTIONAL WEIR.

(b) Laboratory project.
(d) Experimental investigation; for design.
(e) A hyperbolic notch has been designed; the bottom width limited to 1.00 ft and a compensation of 0.01 ft added at the center. A satisfactory straight relationship obtained with a discharge coefficient of 0.60.

(2827) OBLIQUE RATINGS OF A CURRENT METER.

(b) Laboratory project.
(d) Experimental investigation.
(e) A small laboratory current meter by A. Ott, Kempten, Bavaria, has been rated at oblique angles for every 10° up to ±90° in the rating channel of the Hydraulics Laboratory. Deviations were determined from the cosine law for three available runners, one of them so-called "component runner."
(h) "The Use of a Current Meter in Turbulent and Divergent Channels", submitted to the

XI General Assembly of the International Union of Geodesy and Geophysics in Toronto, Sept. 1957. To be published in the Proceedings of the Association of Scientific Hydrology.

OKLAHOMA STATE UNIVERSITY, Agricultural Engrg. Dept.

(2365) HYDROLOGIC STUDIES ON SMALL GRASS-COVERED WATERSHEDS.

(b) Agricultural Experiment Station cooperative with Agricultural Research Service.
(c) Prof. F. R. Crow, Okla. State Univ., Dept. of Agri. Engineering, Stillwater, Okla.
(d) Field investigation; applied research.
(e) Measurements are being made to provide hydrologic data on total watershed runoff and peak rates of runoff from three small grass-covered watersheds (17 to 206 acres) in north central Oklahoma. Highway culverts, modified by the addition of weir sills, are being used as runoff measuring devices.
(f) Intensive model tests of culverts equipped with weir sills completed. Seven year data on precipitation and runoff completed.
(h) "Runoff from Small Watersheds in the Reddish Prairie Grasslands of Oklahoma", W. O. Ree and F. R. Crow. Oklahoma Agricultural Experiment Station Technical Bulletin (in press), Spring 1958.

(2828) THE EFFECTIVENESS OF MONOMOLECULAR FILMS FOR REDUCING EVAPORATION FROM RESERVOIRS.

(b) Oklahoma Agricultural Experiment Station.
(c) Prof. F. R. Crow, Oklahoma State Univ., Dept. of Agricultural Engineering, Stillwater, Okla.
(d) Field investigation; applied research.
(e) Studies are being made on evaporation pans, existing farm reservoirs and plastic lined experimental evaporation reservoirs to develop methods of application and determination of effectiveness of hexadecanol and octadecanol films for reducing evaporation. Effect of wind on stability of monolayers is being studied in low-speed laboratory wind tunnel.

OREGON STATE COLLEGE, Department of Civil Engrg.

(918) RELATION BETWEEN RAINFALL AND RUNOFF FROM SMALL WATERSHED IN WESTERN OREGON.

(b) Laboratory project.
(c) Prof. W. C. Westgarth, Dept. of Civil Engineering, Oregon State College, Corvallis, Oregon.
(d) Field investigation; basic research.
(e) Watershed 7.34 sq mi partly wooded, partly farmed; automatic recording rain gages and flow recording gages on loan from U. S. Weather Bureau and U.S. Geological Survey.

(f) Suspended.

(1654) MODEL INVESTIGATION OF FISH-LADDERS IN BOX CULVERTS.

(b) Cooperative with Oregon State Highway Dept. and Bureau of Public Roads.
(c) Dr. Roy H. Shoemaker, Jr., Oregon State College, Corvallis, Oregon.
(d) Experimental; design.
(e) Scale model of box culvert with fish-ladder baffles installed to determine discharge characteristics of culvert for variable baffle height and spacing.
(f) Completed.
(g) Energy losses evaluated in terms of Darcy-Weisbach pipe friction formula.
(h) "Hydraulics of Box Culverts with Fish-Ladder Baffles." Proceedings of Highway Research Board, Volume 35, pp 196-209.

(2829) MODEL INVESTIGATION OF AN ARTIFICIAL OUTLET FOR DOWNSTREAM MIGRATING FISH AT PELTON DAM, OREGON.

(b) Portland General Electric Company.
(c) Dr. Roy H. Shoemaker, Jr., Dept. of Civil Engineering, Oregon State College, Corvallis, Oregon.
(d) Experimental; applied research, design.
(e) Scale model of artificial outlet tested in model reservoir to determine (a) typical patterns of flow in reservoir as affected by discharge from penstocks, (b) effect of artificial outlet upon magnitude and direction of currents in forebay, (c) effective limits of the zone of influence of the artificial outlet in the forebay and (d) optimum flows into the artificial outlet for satisfactory operation.

PENNSYLVANIA STATE UNIVERSITY, Hydraulics Laboratory, Department of Civil Engineering.

Inquiries concerning projects Nos. 2830 and 2831 should be addressed to Prof. Sam Shulits, Hydraulics Laboratory, Dept. of Civil Engineering, Pennsylvania State University, University Park, Penn.

(2830) EDDY VISCOSITIES IN OPEN CHANNELS.

(b) Laboratory project.
(d) Theoretical, basic.
(e) To determine magnitude of eddy viscosities in open channels from measured velocity profiles; to investigate suspected correlations with open channel parameters; to explore questioned constancy of Von Karman's "universal constant", k.
(g) A systematic relationship seems to exist between k and the channel roughness coefficient.

(2831) FORCES ON RIPRAP REVETMENT.

(b) Laboratory project.
(d) Experimental; basic.
(e) A single rectangular block as an idealized

stone will be studied first on the bottom of a flume (uniform depth of water on top of block) and then on an inclined surface (non-uniform depth). The block will then be surrounded with other blocks, in a series of orderly patterns, to simulate a riprap-protected bank. Perhaps systematic relations can be found between physical dimensions of the block pattern and the hydrodynamic parameters due to the flowing water, in the manner in which Nikuradse and Schlicting organized their experimental research on surface roughness.
(g) Exploratory test on one block. Systematic experimentation starts February 1958.

THE PENNSYLVANIA STATE UNIVERSITY, Ordnance Research Laboratory, Garfield Thomas Water Tunnel.

(2369) TURBULENCE DETECTION THROUGH THERMISTORS.

(b) Laboratory project.
(c) Mr. A. F. Lehman, Ordnance Research Laboratory, University Park, Penn.
(d) Experimental; developmental.
(e) A thermistor was used in exploring the possibilities of using this device as a turbulence detector or as a means of measuring turbulence in water.
(f) Completed.
(g) Thermistor information obtained by traverses in radial planes in the wake of a powered model was evaluated through a comparison of air turbulence sphere and water tunnel turbulence sphere data to derive turbulence (intensity) levels. While the thermistor is limited in terms of frequency response to about 250 cps and a number of assumptions were made in obtaining thermistor-level turbulence-level correlation, the technique should prove worthwhile in normal engineering applications.

(2370) MASS TRANSFER DEVICE FOR MEASURING VELOCITIES AND TURBULENCE IN WATER.

(b) Laboratory project.
(c) Dr. W. E. Ranz, Ordnance Research Laboratory, University Park, Penn.
(d) Experimental and theoretical; applied research.
(e) The study concerned the basic problem of measuring turbulence in water and also concerned the investigation of flow conditions in water through a mass transfer phenomena.
(f) Completed.
(g) A series of experiments were performed which showed that a working instrument could be designed on the principle of convection-controlled electrolysis. Disappointing was the lack of a simple relationship between current and velocity. Beyond purely chemical limitations, factors such as the contamination of the surface area which changed the calibration

of the probe, size of the probe necessary
for mechanical strength to withstand hydro-
dynamic forces together with a limitation
of turbulence scale and frequency by probe
size were also considered. Practical
instruments appear to be possible but only
after long development and considerable
study of chemical mechanisms.

(h) "Electrolytic Methods for Measuring Water
Velocities", by W. E. Ranz, ORL Unclassified
Technical Memorandum, File No. TM 19.8854-5,
dated Feb. 20, 1957.

(2594) SCALE EFFECTS ON THE INCIPIENT CAVITATION
CONNECTED WITH LOCAL SURFACE IRREGULARITIES.

(b) Laboratory project sponsored by the Bureau
of Ordnance.
(c) Mr. J. William Holl, Ordnance Research
Laboratory, University Park, Penna.
(d) Theoretical and experimental.
(e) An investigation of the effect of the ratio
of the roughness height to the boundary
layer thickness as isolated from the effect
of the over-all shape of the parent body.
Investigations will be performed on a flat
plate spanning the 12-inch diameter working
section of the high speed water tunnel.
Heights of irregularities will range down
to .005 inch.
(g) Results of tests conducted in the 48-inch
tunnel on irregularities from 1/16 inch to
1/2 inch in height in boundary layers
ranging up to 1 inch thickness indicated
significant variations of the incipient
cavitation number with both size and
velocity.
(h) "Cavitation Inception of Surface Irregu-
larities", by J. William Holl, ORL Unclas-
sified Technical Memorandum, File No. TM
5.3410-03, dated Dec. 1957.

(2832) MEASUREMENT OF FORCES ON A MODEL IN A
WATER TUNNEL.

(b) Laboratory project.
(c) Messrs. T. E. Peirce and G. B. Gurney,
Ordnance Research Laboratory, University
Park, Penna.
(d) Experimental; developmental.
(e) The problem concerns the measurement of
forces on models in a water tunnel over a
velocity range up to 80 fps, pressure
ranges of 3 to 60 psia.
(g) Methods for waterproofing strain gages per-
mitting application to flooded internal
balance systems satisfactorily developed.
A three-component balance (lift, pitching
moment, and roll) for use with an 8-inch
diameter model at velocities to approxi-
mately 40 fps over the stated pressure
range now in operation.

(2833) EXCITATION OF CAVITY RESONANCE BY WATER
FLOW.

(b) Laboratory project.
(c) Mr. A. F. Lehman, Ordnance Research Labora-
tory, University Park, Penna.
(d) Experimental; basic research.

(e) Several models will be constructed and
tested in the ORL Garfield Thomas Water
Tunnel for the purpose of experimentally
investigating the excitation of cavity
resonance by water flow past an opening.

(2834) INCIPIENT CAVITATION UNDER UNSTEADY
CONDITIONS.

(b) Laboratory project.
(c) Mr. J. J. Eisenhuth, Ordnance Research
Laboratory, University Park, Penna.
(d) Theoretical; experimental.
(e) This investigation is concerned with the
unsteady interaction between propeller
blades and the wakes of stationary control
surfaces. The particular goal is to learn
the effects on incipient cavitation of
propeller blades when passing through
these wakes.

PURDUE UNIVERSITY, Department of Agricultural
Engineering.

(2595) A MODEL STUDY OF BREATHERS AND RELIEF
WELLS FOR TILE DRAINS TILE LINES.

(b) Department of Agricultural Engineering,
Purdue University.
(c) Mr. Harold Honeyfield, Department of
Agricultural Engineering, Purdue Univer-
sity, Lafayette, Indiana.
(d) Experimental, for a master's thesis.
(e) Work is being done to determine whether
breathers are necessary in tile lines.

(2596) THE DEVELOPMENT AND USE OF A RAINFALL
SIMULATOR FOR SOIL AND WATER MANAGEMENT
STUDIES.

(b) Agricultural Research Service, SWC, ESW,
USDA and Purdue University.
(c) Mr. L. Donald Meyer, ARS, Agricultural
Experiment Station, Purdue University,
Lafayette, Indiana.
(d) Experimental, development, operation.
(e) Methods of simulating rainfall, using the
kinetic energy of the drops as the primary
comparison, have been investigated. A
portable rainfall simulator has been
designed, constructed, and is in use as a
tool to aid in the rapid evaluation of
factors that influence runoff, erosion,
and infiltration. Commercial spray noz-
zles are used to apply intensities of
2 1/2 and 5 inches per hour to standard
runoff study plots. Construction of the
simulator in units makes it possible to
vary the number and size of plots that
are covered simultaneously. Present use
of the simulator is primarily for quali-
tative evaluations of various topographic,
soil, water, crop, and management factors
under controlled field conditions.

(2835) A PRELIMINARY INVESTIGATION OF WATER
TABLE CONTROL IN SANDY LOAM SOIL IN
NORTHWESTERN INDIANA.

(b) Departments of Agricultural Engineering
and Agronomy, Purdue University.
(c) Mr. Walter D. Lembke, Instructor in
Agricultural Engineering, Purdue University.
(d) Field investigation, applied research.
(e) Piezometers and observation wells are being
used to measure how effective are present
attempts to control the water table.

(2836) THE EFFECT OF VERTICAL MULCH CHANNELS ON
THE INFILTRATION RATE IN A PASTURE SOIL.

(b) Department of Agricultural Engineering,
Purdue University.
(c) Mr. Donn DeCoursey, Graduate Student,
Department of Agricultural Engineering,
Purdue University.
(d) Field investigation, applied research.
(e) A rainfall simulator is used to apply con-
trolled rainfall on small plots. The
resulting runoff hydrographs are analyzed
for depression storage and infiltration.

(2837) TREATMENT OF SURFACE WATERS FOR DOMESTIC
USE ON THE FARM.

(b) Department of Agricultural Engineering,
School of Civil Engineering, Purdue Univ.,
Lafayette, Indiana, and State Board of
Health, Indianapolis, Indiana.
(c) Mr. Carroll R. Amerman, Graduate Assistant,
Department of Agricultural Engineering,
Purdue University, Lafayette, Indiana.
(d) Field investigation for a master's thesis.
(e) Work is being done to compare effectiveness
of slow sand filters and diatomaceous
earth filters.

PURDUE UNIVERSITY, School of Chemical and Metal-
lurgical Engineering.

(2838) OPERATING CHARACTERISTICS OF THE JET SPRAY
DRYER.

(b) U. S. Army Chemical Corps Biological
Warfare Laboratories.
(c) Dr. E. W. Comings, School of Chemical and
Metallurgical Engineering, Purdue Univ.,
Lafayette, Indiana.
(d) Experimental investigation; applied
research for M.S. and Ph.D. theses.
(e) A jet spray dryer has been built and
operated over a range of conditions using
a solution of aqueous sodium sulfate and
a suspension of serratia marcescens.
(f) Completed.
(g) An improved model of the jet spray dryer
has been used to dry sodium-sulfate solu-
tion, a suspension of serratia marcescens,
milk, and eggs. The drying of sodium-
sulfate solution is described. The product
was composed of solid spheres with a
geometric-mass-mean diameter of 3.2 to
4.4 microns. Calculated drying times of
2 to 20 milliseconds and particle travel
during drying of less than 2 feet were
consistent with the observed results.
Some of the operating variables were as

follows:

Primary-air temperature   350 to 550°F.
Secondary-air temperature 125 and 175°F.
Liquid feed rates   2 and 3 gal/hr.
Btu added per lb. water
  evaporated   2400 to 10,000

The jet spray dryer was used to dry sus-
pensions of serratia marcescens, a bac-
terium, under a variety of operating
conditions. Recoveries of viable cells
were measured, and ranged from 1.8 to
91.8 percent. For more than half of the
drying runs the viable recovery was
between 40 and 60 percent. The moisture
content of the dried product was between
4 and 8 weight percent. The particle
size of the dried product, as measured
in one experiment, had a mass mean diam-
eter of 5.1 microns with a geometric mean
deviation of 1.6. Half-life values were
determined for the dried organisms stored
under various conditions and the maximum
value was found to be 245 days for bac-
teria stored under partial vacuum
(pressure of 0.05 mm Hg) at -30°C.
(h) "Drying Aqueous Sodium Sulfate in the Jet
Spray Dryer", H. A. McLain, E. W. Comings,
and J. E. Myers. Submitted for presenta-
tion at the Boston meeting of the American
Institute of Chemical Engineers, December
9-12, 1956.
"Spray Drying of Serratia Marcescens in
the Jet Spray Dryer", E. W. Comings,
Harry Higa, Henry Koffler, and H. A.
McLain. Submitted for presentation at
the Miami meeting of the Division of
Industrial and Engineering Chemistry of
the American Chemical Society, April 7-12,
1957.

PURDUE UNIVERSITY, School of Civil Engineering.

(2599) MODEL STUDY OF A PORTION OF THE WHITE
RIVER.

(b) Indianapolis Power and Light Company,
Indianapolis, Indiana.
(c) Dr. J. W. Delleur, Civil Engineering,
Purdue University, Lafayette, Indiana.
(d) Experimental; for design, for master
thesis.
(e) Investigation and improvements in the
hydraulic flow patterns of the White
River in the vicinity of Harding Street
Power Plant of the Indianapolis Power
and Light Company.
(f) Completed.
(g) Dredging of the stream bed and installa-
tion of a submerged groin were recom-
mended in order to eliminate the con-
tinual deposition of sediments in the
vicinity of the intake, and to permit a
larger pumping rate. Recirculation was
was also considered.
(h) "Model Study of the White River in the
Vicinity of Harding Street Power Plant",

by J. W. Delleur, J. M. Alexander and
C. Venkatadri, Purdue University, School
of Civil Engineering, Hydraulics Laboratory,
March 1957.

(2839) HYDRAULICS OF RIVER FLOW UNDER ARCH BRIDGES.

(b) State Highway Department of Indiana.
(c) Dr. J. W. Delleur, School of Civil Engrg.,
Purdue University, Lafayette, Indiana.
(d) Experimental, master theses.
(e) The purpose of the research is to study
systematically the hydraulic efficiency of
waterways under arch bridges, to provide a
criterion for determining the proper clear
span of arch bridges so as to compensate
for the loss of efficiency at high flows,
and to provide a method for computing the
backwater upstream of arch bridges.
(g) The design of the laboratory flume and
models is under way.

(2840) MECHANISM OF TURBULENCE IN FREE SURFACE
FLOW.

(b) Purdue Research Foundation Fellowship.
(c) Dr. J. W. Delleur, Civil Engineering,
Purdue University, Lafayette, Indiana.
(d) Theoretical and experimental, for Ph.D.
thesis.
(e) Theoretical and experimental study of the
turbulent velocity field and of boundary
layers in open channel flow. Measurement,
analysis and correlation of turbulent
velocity components and turbulent stresses.

(2841) STUDY RUNOFF FROM SMALL WATERSHEDS FOR
HIGHWAY DRAINAGE DESIGN IN INDIANA.

(b) State Highway Department of Indiana.
(c) Dr. J. W. Delleur, School of Civil Engrg.,
Purdue University, Lafayette, Indiana.
(d) Analysis and field investigation.
(e) The purpose of the research is to study
the hydrology of watersheds less than 50
square miles throughout the State of
Indiana, to improve the existing methods
for estimating the runoff from these water-
sheds, and to improve the existing methods
of design of highway drainage structures
servicing small watersheds.
(g) Runoff and rainfall data are being col-
lected.

(2842) FLOW THROUGH A POROUS MEDIA.

(b) Laboratory project.
(c) Prof. Warren E. Howland, School of Civil
Engrg., Purdue University, Lafayette, Ind.
(d) Theoretical; mathematical consideration of
problem.
(e) A theoretical consideration of the flow
through a trickling filter used in the
purification of sewage. The theory was
demonstrated to be true when substantiated
with laboratory test data.
(f) Completed.
(g) The rate of flow through a trickling filter
can be calculated.
(h) "Flow Through a Porous Media, as in a

Trickling Filter", Proceedings of the
Twelfth Purdue Industrial Waste Conference,
Series 94, Engineering Extension Dept.,
Vol. 42, No. 2, June 1958.

(2843) SELECTING IRRIGATION PIPE SIZES FOR
ECONOMY.

(b) Laboratory project.
(c) Prof. Warren E. Howland, Civil Engineer-
ing, Purdue University, Lafayette, Ind.
(d) Theoretical; mathematical consideration
of the problem.
(e) Two methods are presented for determining
the most economical combinations of
lengths and standard sizes for a pipe to
irrigate a narrow strip of field of a
given length at a given rate of discharge
per unit length of pipe and at a given
total head loss.
(f) Completed.
(g) The most economical pipe sizes can be
determined.
(h) "Selecting Irrigation Pipe Sizes for
Economy", Warren E. Howland, Agricultural
Engineering, Vol. 38, No. 7, pp. 530-534,
July 1957.

(2844) EXPERIMENTAL TRICKLING FILTER STUDIES.

(b) Ayer-McCarel Clay Company, Inc.;
Bowerston Shale Company; Texas Vitrified
Pipe Company; Cannelton Sewer Pipe Co.,
Natco Corporation and Pomona Terra Cotta
Company.
(c) Prof. D. E. Bloodgood, Civil Engineering,
Purdue University, Lafayette, Indiana.
(d) Experimental research in laboratory.
(e) The experimental filter used in this
research consisted of a trough 45 inches
long, 7 inches wide, one inch deep, hinged
at the lower end so that the slope of the
trough could be varied. The trough filter
was supported on a beam scales so that
the contact time could be determined from
the weight of liquid on the surface of
the filter. The effect of slime on the
rate of passage was studied.
(f) Completed.
(g) "Influence of Contact Time Upon Purifica-
tion of Capacity of an Experimental
Trickling Filter", Master's Thesis by
Joseph Ernest Rempe.

(2845) INFLUENCE OF MEDIA SURFACE AREA UPON THE
PERFORMANCE OF AN EXPERIMENTAL TRICKLING
FILTER.

(b) Ayer-McCarel Clay Company, Inc.,
Bowerston Shale Company; Natco Corpora-
tion; and Pomona Terra Cotta Company;
and Cannelton Sewer Pipe Company.
(c) Prof. D. E. Bloodgood, Civil Engineering,
Purdue University, Lafayette, Indiana.
(d) Experimental research of basic factors
involved in flow and removal of organic
matter.
(e) A single string of 3-1/3 inch diameter
rubber balls which was 23 feet long was
constructed. The apparatus was dosed

with single passes of synthetic sewage with concentrations between 28.8 ppm of C.O.D. and 1020 ppm of C.O.D. which were applied at continuous application rates between 18.5 MGAD and 272 MGAD.

(h) "Influence of Media Surface Area Upon the Performance of an Experimental Trickling Filter", Master's Thesis by James H. McDermott.

(2846) CORROSION OF WATER MAINS.

(b) Laboratory project.
(c) Prof. Harvey R. Wilke, Civil Engineering, Purdue University, Lafayette, Indiana.
(d) Experimental; laboratory testing.
(e) The determination of the effect of high dosages of chlorine on the lining of cast iron pipe used in the distribution of potable water.
(f) Completed.
(g) If the coal tar lining is free of defects there is no increase of iron in the water.
(h) A thesis is being prepared on the research.

PURDUE UNIVERSITY, Jet Propulsion Center.

(2373) A STUDY OF THE MECHANISM OF FILM COOLING INCLUDING MASS TRANSFER.

(b) Project Squid, Contract N6 ori-105 T.O. III, Phase II, Problem 11 R2, PRF 1079 - Fund 5976 M-226.
(c) Dr. Maurice J. Zucrow, Jet Propulsion Center, Purdue University, West Lafayette, Ind.
(d) Experimental and theoretical investigation; basic research, partially for master's and doctoral theses.
(e) This problem is concerned with the experimental investigation of the stability of liquid films formed by injecting a liquid through spaced parallel disks into a gas stream, and the heat and mass transfer between the gas stream and the liquid film. One of the objects of the study is to obtain data which will establish the conditions for producing a stable liquid film, for cooling purposes, on the walls of the duct through which a hot gas is flowing. The criterion of film stability adopted for this investigation is the magnitude of the critical velocity of injection, defined as the maximum mean velocity of the injected liquid that does not produce separation of the liquid film from the test section wall.
(f) Completed.
(g) A systematic investigation of the critical velocity of injection as a function of air velocity, slot configuration, duct configuration, liquid properties and gas stream properties has been undertaken. The results of the investigation showing the effects of all of the variables given above with the exception of the viscosity of the flowing gas, has been reported.
(h) "Project Squid Progress Report", April

1956.
"Investigation of the Factors Affecting the Attachment of a Liquid Film to a Solid Surface", C. F. Warner and B. A. Reese. Jet Propulsion, Vol. 27, No. 8, pp. 877 to 881, August 1957.

(2374) THE MECHANISMS OF TWO PHASE FLOW OF ANNULAR LIQUID FILMS IN A VERTICAL TUBE.

(b) Project Squid, Contract N6 ori-105 T.O. III, Phase II, Problem 11 R3.
(c) Dr. M. J. Zucrow, Jet Propulsion Center, Purdue University, West Lafayette, Ind.
(d) Experimental and theoretical; basic research for doctoral thesis.
(e) This problem is concerned with the analytical and experimental study of the mechanisms of the downward flow of a liquid film on the inside wall of a vertical circular tube with co-current gas flow in the core of the tube.
(g) Experimental program is in progress.
(h) "Project Squid Progress Report", October 1957 and references therein.

REED RESEARCH INCORPORATED.

(2375) ON THE CODIFICATION OF HYDRAULICALLY ROUGH SURFACES.

(b) Office of Naval Research, Department of the Navy, (David Taylor Model Basin Technical Supervision).
(c) Mr. Robert Taggart, Reed Research, Inc., 1048 Potomac St., N.W., Washington 7, D.C.
(d) Experimental; applied research.
(e) Direct measurements of wall shear stress are made on a series of 4-inch square plates containing randomly distributed projection-type roughness elements. Velocity distributions are measured at the downstream end of the plate. The roughness effect of each of 16 roughened surfaces is being studied by measuring the downward shift of the logarithmic region of the velocity distribution from that of a smooth case. Experiments are being carried out in a rectangular water channel (aspect ratio 9:1) and the range of Reynolds numbers is from $R = 1.1 \times 10^5$ to $R = 7.5 \times 10^5$ (based on tunnel size).
(f) Suspended.
(g) Test results demonstrated excellent correlation between tests on small plates and tests conducted in completely roughened tunnels. Extremely minute roughnesses were shown to have a measurable effect on resistance and velocity distribution.
(h) "Preliminary Report on Roughness Characteristics", by Matthew Stevenson, Reed Research, Inc. Report Number RR-682, 46 pages, 26 April 1957. Copies may be obtained from Reed Research, Inc.

(2601) MEASUREMENT OF NOISE CREATED BY UNDERWATER EMISSION OF AIR BUBBLES.

(b) Office of Naval Research, Department of the Navy, (David Taylor Model Basin Technical Supervision).
(c) Mr. Robert Taggart, Reed Research, Inc., 1048 Potomac St., N.W., Washington 7, D.C.
(d) Experimental.
(e) A quiet 12,000 gpm flow facility has been constructed for the purpose of measuring the noise created by underwater emission of air bubbles, at various water velocities. The fundamental requirement for this facility is that it provide a quiet flow of water up to a speed of twenty feet per second through a one-foot diameter test section into which the experimental devices can be inserted. Hydrophones are placed, out of the flow, in an acoustically and optically transparent enclosure, to measure the waterborne noise. Photographs can be taken of the bubbles.
(g) The facility has proved to be exceedingly quiet up to the maximum rate of flow. Tests have been completed on two bubble emitters. Noise levels were found to increase only slightly with increasing water velocity and air flow rate.

(2847) RESEARCH AND INVESTIGATION ON THRUST DEDUCTION.

(b) Office of Naval Research, Department of the Navy (David Taylor Model Basin Technical Supervision).
(c) Mr. Johann Martinek, Research Division, Reed Research Inc., 1048 Potomac Street, N.W., Washington 7, D. C.
(d) Theoretical; basic research.
(e) The conditions for maximum useful power output for given power input of a deeply submerged body of revolution of prescribed displacement volume are analyzed.
(f) Completed.
(g) An analysis is presented leading to a system of algebraic equations which determines certain body shape and propeller characteristics of a self-propelled body of revolution moving at constant speed at zero angle of incidence in an infinite ideal fluid domain at a maximum useful power for a given constant power input and prescribed displacement volume. The equations give a relationship between the body shape parameters and all other parameters defining the body, propeller, body-propeller relative position, and flow. By means of Weiss' "Sphere Theorem" and Dickmann's concept, employing a single sink as a substitute for a propeller, an analogy has been established between the system sphere-sink and body-sink based upon the equivalence of the interaction forces. The frictional interaction force is then approximately derived by the use of Hoerner's resistance formula and the propeller flow as given by Dickmann. The diameter of the frictional belt which is needed for determining the potential interaction force has been found by qualitative comparison of plate and body turbulent boundary layer flow.

(h) "Final Report on Research and Investigation on Thrust Deduction", by J. Martinek, G.C.K. Yeh and L. Crawford to Office of Naval Research for Contract NOnr 1117(00), Oct. 31, 1953.
"On Potential Wake and Thrust Deduction", by J. Martinek and G.C.K. Yeh, International Shipbuilding Progress, Vol. 1, No. 2, pp. 89-92, 1954.

(2848) THEORETICAL STUDIES OF WAKE AND THRUST DEDUCTION.

(b) David Taylor Model Basin, Department of the Navy (Bureau of Ships Fundamental Hydromechanics Research Program).
(c) Mr. Johann Martinek, Research Division, Reed Research Inc., 1048 Potomac Street, N.W., Washington 7, D.C
(d) Theoretical; basic research.
(e) This is the continuation of a theoretical study of ideal incompressible fluid flow related to the problem of interaction between propeller and ship (Project No. 2847 above). The objective was to explore and investigate the basic elements of flow interaction and to approach gradually the extremely complicated phenomena of ship-propeller-rudder interaction. Body shapes are extended from spheres to spheroids. Propeller representations are extended from a single sink to sink disks, vortex cups and vortex disks. Survey of literature pointed to the need of additional mathematical tools and new theorems.
(f) Completed.
(g) The study led to a significant contribution to potential theory in three dimensions. "The Sphere Theorem in Potential Theory", "A General Sphere Theorem for Hydrodynamics, Heat, Magnetism and Electrostatics", and "A Double Sphere Theorem" have been established. The potentials due to a source-sink pair, a general doublet and circular vortex ring inside and outside a fixed sphere have been derived. The potentials due to a uniform flow, a sink, a radial doublet, a vortex ring, a sink cup and a sink disk outside a prolate spheroidal body have been obtained. Image of a variable vortex disk in a sphere has been found with application to propeller flows. The essential results have been published in leading international journals.
(h) "Final Report II on Theoretical Studies of Wake and Thrust Deduction - A Contribution to Potential Theory in Three Dimensions", by J. Martinek, G.C.K. Yeh and H. Zorn, for Contract NOnr 1445(00), Bureau of Ships Fundamental Hydromechanics Research Program (NS-715-102) June 30, 1955.
"The Sphere Theorem in Potential Theory", by G.S.S. Ludford, J. Martinek and G.C.K. Yeh, Proceedings of the Cambridge Philosophical Society, Vol. 51, pp. 389-393, 1955.
"The Potentials Due to Certain Singularities in the Presence of a Fixed Sphere", by G.C.K. Yeh, J. Martinek and

G.S.S. Ludford, Journal of the Society of Industrial and Applied Mathematics, Vol. 3, pp. 142-152, 1955.
"A General Sphere Theorem for Hydrodynamics, Heat, Magnetism and Electrostatics", by G.C.K. Yeh, J. Martinek, and G.S.S. Ludford, Zeitschrift für angewandte Mathematik und Mechanik, Vol. 36, pp. 111-116, 1956.
"Potential and Stream Function of a Vortex Disk in the Presence of a Rigid Sphere", by J. Martinek, G.C.K. Yeh and H. Zorn, Proceedings of the Cambridge Philosophical Society, Vol. 53, pp. 717-727, 1957.
"The Potential of a General Dipole in a Homogeneous Conducting Prolate Spheroid", by G.C.K. Yeh and J. Martinek, Annals of the New York Academy of Sciences, Vol. 65, Art. 6, pp. 1003-1006, 1957.

(2849)   EFFECTIVE WAKE AND THRUST DEDUCTION FOR DEEPLY SUBMERGED BODIES.

(b)   David Taylor Model Basin, Department of the Navy (Bureau of Ships Fundamental Hydromechanics Research Program).
(c)   Mr. Johann Martinek, Research Division, Reed Research Inc., 1048 Potomac Street, N. W., Washington 7, D. C.
(d)   Theoretical; basic research.
(e)   The hydrodynamic interaction of a hull-propeller combination moving at a great depth under the free surface is analyzed.
(f)   Completed.
(g)   On the basis of Oseen's form of the motion equations, Euler's theorem, and Lagally's exterior theorem for a stream with singularities at a finite distance from a closed body, a general expression for the thrust deduction fraction ⊚ (which is also valid for highly loaded propellers) is derived. The application of the theory to the ovoid hull combinations tested by Weitbrecht gives values of ⊛ slightly lower than the measured ones. This confirms the opinion of Dickmann and van Manen that for the case of radial symmetry the frictional thrust deduction is small. Numerical results for different configurations of a prolate ellipsoid hull and propeller are presented in tabular form. The results indicate that the thrust deduction fraction exhibits a rapid diminution with the increase of the distance of the propeller from the stern and with the increase of propeller diameter.
(h)   "Report on Effective Wake and Thrust Deduction for Deeply Submerged Bodies", by R. Hunziker, April 2, 1956.
"Final Report III on Effective Wake and Thrust Deduction for Deeply Submerged Bodies - The Influence of Body Shape Variation on the Thrust Deduction Coefficient", by R. Hunziker, Aug. 30, 1956. Both reports to David Taylor Model Basin for Contract NOnr 1445(00), Bureau of Ships Fundamental Hydromechanics Research Program, Project NS-715-102.

(2850)   THRUST DEDUCTION EVALUATION OF A SUBMARINE.

(b)   David Taylor Model Basin, Department of

the Navy.
(c)   Mr. J. Martinek, Research Division, Reed Research Inc., 1048 Potomac Street, N.W., Washington 7, D. C.
(d)   Theoretical; basic research.
(e)   In Projects 2847 and 2848 above, a theoretical foundation is laid for analyzing the thrust deduction of a deeply submerged self-propelled body of revolution. It is the purpose of this project to demonstrate the use of the analyses by carrying out a numerical evaluation for an actual vessel. The hydrodynamic test submarine Albacore is thought to be the most appropriate one. The following steps will be worked out: (1) To approximate the shape of Albacore by various shapes or equivalent shapes considered in Projects Nos. 2847 and 2848. (2) To approximate the propellers of Albacore by various combinations of singularities discussed in Projects Nos. 2847 and 2848. (3) By means of the theorems and formulas in Projects Nos. 2847 and 2848 evaluate for each combination of the bodies and singularities obtained in (1) and (2) the potential interaction force, the frictional interaction force, and the thrust deduction. (4) To compare the results for various combinations and determine the plausible choice.

(2851)   THE CONSTRUCTION OF THE TOTAL HARMONIC VELOCITY FIELD AROUND A GENERAL ELLIPSOIDAL SUBMARINE.

(b)   David Taylor Model Basin, Department of the Navy (Bureau of Ships Fundamental Hydromechanics Research Program).
(c)   Mr. J. Martinek, Research Division, Reed Research Inc., 1048 Potomac St., N.W., Washington 7, D. C.
(d)   Theoretical; basic research.
(e)   As an extension of Project No. 2849 it is proposed to carry out the hydrodynamical analysis and effective construction of the velocity field (in steady flow approximation) around an arbitrary ellipsoidal hull (a shape of three unequal axes) with one or more propellers. A new type of expansion in terms of Lamé functions will be used. The general formulas for the average nominal potential wake fraction ψ_1 and effective average potential wake fraction $\psi_1 + c/U \psi_2$ for the ellipsoidal hull and propeller combination can be derived. (-U is the absolute velocity of the hull and c is the net augmentation of velocity in the propeller slipstream at infinity.) Then ψ_1, ψ_2, and the potential thrust deduction fraction ⊙ for some specific configurations can be tabulated.

(2852)   STEADY FLUID MOTION UNDER A FREE SURFACE.

(b)   David Taylor Model Basin, Department of the Navy (Bureau of Ships Fundamental Hydromechanics Research Program).
(c)   Mr. J. Martinek, Reed Research, Inc., 1048 Potomac Street, N.W., Washington 7, D. C.

(d) Theoretical; basic research.

(e) The Laplace equation, which is the usual field equation used when trying to solve problems of wave resistance, wave profile, etc., has known solutions in the infinite domain. In most cases the phenomenon under consideration can be established mathematically in an infinite domain. Yet whenever the problem occurs of finding a solution to the same phenomenon subjected to a free surface, great difficulties are encountered. Moreover, if the source of disturbance lies close to the free surface, the functions used to present the potential solution in series form will fail to converge rapidly enough to be useful for numerical computation. It is the object of this project to produce new tools for such problems in closed forms which can be easily and quickly handled by an average engineer. Two theorems will be established for expressing the disturbance velocity potential due to the presence of a free surface in terms of any given potential in an unlimited domain. The first theorem deals with stationary and oscillating phenomena; the second theorem deals with steadily moving phenomena. Specific applications of the theorems to moored and moving self-propelled bodies are also proposed.

(2853) SLAMMING DUE TO PURE PITCHING MOTION WITH CONSIDERATION OF THE ELASTICITY OF THE SHIP.

(b) David Taylor Model Basin (Bureau of Ships Fundamental Hydromechanics Research Program).

(c) Mr. J. Martinek, Research Division, Reed Research Inc., 1048 Potomac Street, N.W., Washington 7, D. C.

(d) Theoretical; basic research.

(e) In all previous theoretical investigations on slamming the ship has been assumed rigid and the resulting pressure distribution and moments are then applied to the main structure of the hull to obtain information on strength requirements. It is, however, well known that the real problem of mutual interaction between fluid (water) and elastic solid (ship) leads to pressure distribution and moments which can be in considerable discord with the results of rigid body mechanics. With the increase of speeds and sizes of modern vessels the effect of ship elasticity on slamming becomes more and more important. It is the purpose of this project to carry out an analysis of slamming due to pure pitching motion of an elastic beam by the principle of work and energy. Forces considered include the inertia force, lift force, weight of ship, dynamic pressure, force due to piled-up water, force due to added mass, and the propulsive force. An attempt will be made to obtain the pressure distribution on a model test set up.

(2854) HEAT TRANSFER IN TURBULENT PIPE FLOW.

(b) Office of Scientific Research, U. S. Air Force.

(c) Mr. Johann Martinek, Research Division, Reed Research Inc., 1048 Potomac Street, N.W., Washington 7, D.C.

(d) Theoretical; basic research.

(e) Heat transfer to and from fully developed turbulent flow with or without heat sources in a circular pipe and between parallel plates is analyzed. The corresponding boundary value problems for temperature distribution are also solved.

(f) Completed.

(g) The use of Pai's velocity and correlation distribution allows a consistent determination of the eddy diffusivity of heat $\epsilon_H = \alpha \epsilon_M$. With the classic hypothesis $\alpha = 1$ a new and better fitting to the experimental Nusselt number data for liquid metals is obtained. The distributions of local Nusselt number over the walls for various heat source intensities are determined. Prandtl's "heat source theorem" is generalized for fluid containing real volume heat sources, giving the asymptotic distribution of temperature as proportional to the velocity profile.

(h) "Heat Transfer in Turbulent Pipe Flow", by R. R. Hunziker, Technical Note No. 1 to Mechanics Div., Office of Scientific Research AFOSR No. TN-57-219, ASTIA Doc. No. AD 126517, April 1957.
"Heat Transfer in Turbulent Pipe Flow with Volume Heat Sources", by J.S. Florio and R. R. Hunziker, Tech. Note No. 2 to Mechanics Div., Office of Scientific Research for Contract No. AF 18(603)-104, April 1957.
"On Turbulent Flow and Eddy Heat Transfer Diffusivity in a Pipe", by R. R. Hunziker and J.S. Florio, Journal of the Aeronautical Sciences, Oct. 1957, pp. 782-784.

ROCKY MOUNTAIN HYDRAULIC LABORATORY.

(2140) EVALUATION OF OPEN-CHANNEL FRICTION LOSSES.

(b) National Science Foundation, U.S. Geological Survey, State Univ. of Iowa, Ohio State Univ., and Colo. State Univ. cooperating.

(c) Prof. C.J. Posey, Director, Rocky Mountain Hydraulic Laboratory, Allenspark, Colorado (summer). State University of Iowa, Iowa City, Iowa (winter).

(d) Experimental; basic.

(e) Variable slope flume long enough to permit accurate evaluation of open-channel friction losses is being tested at slopes into the steep range.

(g) Active experimentation during summers. V-shaped flume tested with batten roughnesses during summer of 1957.

(h) "Tests of the Flow of Water in a Smooth V-shaped Flume", by R. W. Powell and C. J. Posey, Rocky Mountain Hydraulic Laboratory Report No. 21, June 1957.

ST. ANTHONY FALLS HYDRAULIC LABORATORY, University of Minnesota.

Inquiries concerning Projects Nos. 100, 1665, 1669, 1928, 2143, 2144, 2148,2603, 2604, 2605, 2606, 2607, 2610, 2855 to 2859, inc. should be addressed to Dr. Lorenz G. Straub, Director, St. Anthony Falls Hydraulic Laboratory, Mississippi River at 3rd Avenue S.E., Minneapolis 14, Minnesota.

Inquiries concerning Projects Nos. 111, 1168, 1398, 1929, 2386 and 2860, which are conducted in cooperation with the Agricultural Research Service, should be addressed to Mr. Fred W. Blaisdell, Project Supervisor, Watershed Hydrology Section, Soil and Water Conservation Research Branch, Agricultural Research Service, St. Anthony Falls Hydraulic Laboratory, Minneapolis 14, Minnesota.

Projects Nos. 194, 412, 985, 2670, 2923, and 2924, which are conducted at the St. Anthony Falls Hydraulic Laboratory in cooperation with the Corps of Engineers, St. Paul District, St. Paul, Minn., are listed on pages 104 and 105.

(100) AIR ENTRAINMENT RESEARCH.

(b) Office of Naval Research, Department of the Navy.
(d) Theoretical and experimental.
(e) Investigation of self-aeration of high velocity open-channel flow. Air concentrations distributions in the flow have been measured for equilibrium aeration conditions in smooth channel for discharges up to 10 cfs and slopes up to 45° and in artificially roughened channels for discharges up to 15 cfs and slopes up to 75°.
(g) Air concentration distribution in both smooth and rough channels indicates that the flow consists of two parts: (1) open channel flow in lower region with air distributed by turbulent mixing, (2) an upper region consisting of water particles or spray carried through a surface by intense transverse velocity fluctuations. Roughness coefficient for aerated flow decreases with increasing air concentration which depends primarily upon slope and less upon discharge.

(111) CLOSED CONDUIT SPILLWAY.

(b) Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; generalized applied research for development and design.
(e) Tests have been made on three different sizes of Lucite pipe set on slopes ranging from 2.5% to 30% to verify the similarity relationships. Information on discharges, pressures, and flow conditions has been obtained. Characteristics, performance, losses, and pressures in the hood drop inlet are currently being studied.
(g) Theory has been developed, verified, and published. Generalized methods for

analysis and reporting results have been developed. Pipe culverts laid on steep slopes will flow completely full even though the outlet discharges freely. Entrained air did not invalidate the Froude model law. A conduit on either steep or flat slopes will flow full if the hood inlet is used, the hood being formed by cutting the pipe so that the crown projects beyond the invert by 3/4 of a pipe diameter.
(h) "The Hood Inlet for Closed Conduit Spillways and Highway Culverts", by Fred W. Blaisdell and Charles A. Donnelly, Agricultural Engineering, Vol. 37, No. 10, pp. 670-672, October 1956.

(1168) A STUDY OF CANTILEVERED OUTLETS.

(b) Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; generalized applied research for design.
(e) Pipe outlet conduits for small spillways are frequently cantilevered beyond the toe of the earth dam. Attempts will be made to determine quantitatively the size of the scour hole to be expected under various field conditions.
(f) Suspended.

(1398) STRAIGHT DROP SPILLWAY.

(b) Agricultural Research Service, U.S. Department of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; generalized applied research for design.
(e) Spillway is used as a grade control structure in ditches and streams. Study will result in general design rules for the spillway and outlet. Outlet studies have been completed. Present studies are to determine spillway performance and capacity with various approach channel shapes.
(f) Suspended.
(g) No method has yet been found by which the discharge coefficient can be related to the variables.

(1665) LOW VELOCITY WIND INSTRUMENTATION.

(b) U. S. Army Signal Corps.
(d) Experimental design and development.
(e) Development studies on a thermal anemometer for measuring speed and three dimensional direction of atmospheric movements from 1 to 50 fps and from ground to 500 ft elevation using a moored balloon supporting system.
(f) Completed.

(1669) EXPERIMENTAL INVESTIGATION OF BASIC EQUIPMENT AND METHODS ASSOCIATED WITH LABORATORY WAVE STUDIES.

(b) David Taylor Model Basin, Department of the Navy.
(d) Experimental; basic and applied.
(e) Investigation of absorbers and filters for use in laboratory wave studies.
(f) Completed.
(g) Experimental studies were conducted on absorbers and filters in both small and large wave channels. Permeable materials such as crushed-rock, wire-mesh and an arrangement of square bars were very beneficial in absorption of waves. Filter tests indicated high attenuation could be obtained without objectionable reflections.

(1928) DEPRESSED TEMPERATURE STUDIES.

(b) Missouri River Division, Corps of Engineers.
(d) Basic research; analytical and experimental.
(e) An investigation of the effect of temperature changes on the total sediment load in natural streams. The experimental program includes the measurement in a flume of the amount and size distribution of the suspended and bed load sediment in water at various controlled temperatures.
(f) Completed; report being prepared for sponsor.
(g) The total transported load increases markedly with temperature decrease. The rate with a water temperature of 35°F was nearly three times that at 85°F. Most of this increase is apparently contributed by the suspended load since the bed load appears to remain essentially constant. The decrease in fall velocity with depressed temperature is found to sufficiently explain the increased suspended load.

(1929) DRAIN TILE JUNCTION LOSSES.

(b) Minnesota Agricultural Experiment Station in cooperation with the Agricultural Research Service, U. S. Dept. of Agriculture and the St. Anthony Falls Hydraulic Laboratory.
(c) Prof. Philip W. Manson, University of Minnesota, St. Paul Campus, St. Paul, Minn.
(d) Experimental; generalized applied research for design.
(e) The junction losses in drain tile flowing full are determined for laterals of different sizes entering mains of different sizes at various angles. The laterals enter the main at the center line. Additional tests have been made with the crowns (or inverts) of both main and lateral in the same plane.
(g) Tests have been completed on sharp edge junctions entering the main at angles varying in 15 degree increments from 15 degrees to 165 degrees. Both the lateral and the main are completely full. The tests cover all possible combinations of discharge in the lateral and the main. Laterals having areas 1/1, 1/2, 1/4, 1/7, and 1/16 that of the main have been tested. The results are presented in the form of dimensionless curves. The data are being analyzed and a comprehensive report is

planned.
(h) "Hydraulic Characteristics of the Junctions of Equal-Sized Drainage Tile", by Fred W. Blaisdell and Philip W. Manson, Sixieme Congres de la Science du Sol, VI, 14, pp. 561-568, Paris 1956.

(2143) EXPERIMENTAL STUDIES OF SURFACE WAVE ABSORPTION.

(b) Office of Naval Research, Dept. of the Navy.
(d) Experimental; basic research.
(e) Procurement of experimental data on performance and power requirements of pneumatic and hydraulic breakwaters.
(g) Using both small and large models data were obtained on performance and power requirements of hydraulic breakwaters. High attenuations were achieved for waves with length-to-depth ratios between 1 and 2. Scale effects between the two models were of minor importance. Preparations are being made for large-scale tests of pneumatic breakwaters.

(2144) EXPERIMENTAL AND ANALYTICAL STUDIES OF HYDROFOILS.

(b) Office of Naval Research, Dept. of the Navy.
(d) Experimental and analytical; basic research.
(e) Investigation of the basic mechanism of the ventilation of surface-piercing bodies, such as circular cylinders and streamlined lifting struts. Scale effect is of particular interest.
(g) Fundamental studies of the ventilation of semi-submerged circular cylinders coated with Teflon were conducted in an attempt to reduce the scale effect previously found for small-diameter uncoated rods. Results indicated that the Teflon rod data could be more successfully correlated with the Froude number. Studies conducted with streamlined, lifting struts indicated that the Froude number and submergence ratio can be used for correlating ventilation data at high yaw angles. Data for low angle ventilation are not yet complete.

(2148) AIR-WATER MIXTURES IN CLOSED CONDUITS.

(b) David Taylor Model Basin, Department of the Navy.
(d) Experimental research and analysis.
(e) Straight, horizontal conduits involving flow of air bubbles in water are considered. Bubble distribution, friction factor and velocity profile are under study.

(2386) GENERALIZED DESIGN OF TRANSITIONS FOR SUPERCRITICAL VELOCITIES.

(b) Agricultural Research Service, U. S. Dept. of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; generalized applied research for development and design.
(e) Studies will be made to develop a transition

and to determine the rules for its design. The transition will be used to change the flow cross section from circular to rectangular when the velocities are supercritical.

(f) Suspended.

(2603) WATER TUNNEL AIR CONTENT STUDIES.

(b) David Taylor Model Basin, Department of the Navy.
(d) Analytical and experimental.
(e) Determination of improved method for controlling content of free air contained in water tunnel. System involves separation and extraction of large circulating air bubbles, controlled maintenance of small air bubbles (cavitation nuclei) and measurement of the free air content.

(2604) FULL-SCALE TEST OF CONCRETE PIPE.

(b) State Road Department of Florida and Bureau of Public Roads.
(d) Experimental; applied.
(e) Procure experimental data on friction coefficient for 24-inch and 36-inch concrete pipe with (1) joints similar to field conditions and (2) smooth joints. Tests to be performed on both machine-made and Vibro-cast pipe.
(g) Preliminary results indicate that Darcy f for 24-inch machine-made pipe with field joints is about 0.0175; for same pipe with smooth joints f is about 0.0159. Tests of 36-inch pipe are currently underway.

(2605) CALIBRATION OF LARGE VENTURI METERS.

(b) E. I. du Pont de Nemours and Company.
(d) Experimental; applied.
(e) Calibrate large Venturi meters.
(f) Completed.
(g) Measurements were made of differential pressure as a function of discharge for discharges up to 133 cubic feet per second. Accuracy of measurement was about plus or minus one-fourth of one percent.

(2606) PRIEST RAPIDS MODEL STUDIES.

(b) Public Utility District of Grant County, Ephrata, Washington.
(d) Experimental; design and operation.
(e) A 1:120 scale model of the Priest Rapids Development Project on the Columbia River is reproduced to study the hydraulic design of the spillway, powerhouse and fish facilities.
(g) Study in progress.

(2607) PRIEST RAPIDS (COFFERDAM MODEL).

(b) Harza Engineering Co., Chicago; Grant County Public Utility District, and Merritt-Chapman and Scott, contractors.
(d) Experimental; design and operation.
(e) A distorted model, scale 1:60 vertical and 1:180 horizontal is used to determine the placement of the various stages of coffer-

dam construction. Measurements of channel velocities to assure passage of fish migrants during all phases of construction.

(2610) LABORATORY WAVE PROFILE RECORDER.

(b) David Taylor Model Basin.
(d) Experimental; applied.
(e) Study of sonic-ranging type wave profile recorder for specialized laboratory use.
(g) Studies indicate that the sonic ranging principle in air can be successfully applied to an instrument for the recording of water surface-wave profiles. Performance tests were made with equipment mounting on a towing carriage for towing speed up to 20 feet per second and wave length as short as 2 feet without apparent effect on recording. Operation is limited to wave with a maximum incremental steepness of .3.

(2855) PRIEST RAPIDS EAST BANK FISH FACILITIES MODEL.

(b) Public Utility District of Grant County, Ephrata, Washington.
(d) Experimental; design and operation.
(e) A 1:24 scale model of Priest Rapids fish ladder, junction pool, gravity intake system, and attraction water supply channel including experimental design of all diffusion chambers, also a 1:48 model of the gravity intake system. For design and operational studies.
(g) Study in progress.

(2856) SEEPAGE FROM EARTH CANAL.

(b) Laboratory project.
(d) Experimental and analytical; master's thesis.
(e) Flow nets for the seepage flow from earth canals were analyzed using an electric field plotter and a hydraulic analog and were compared with an approximating transformation function.
(f) Completed.
(g) Shape factors for the flow nets were related to canal geometries for side slopes from 2.5:1 to vertical.
(h) "Study of Seepage from Earth Canals by Hydraulic and Electric Analog", by Albert G. Mercer, Master's Thesis, on file at the University of Minnesota Library, Nov. 1957.

(2857) EFFECT OF BLOCKS ON HYDRAULIC JUMP.

(b) Laboratory project.
(d) Experimental and analytical; master's thesis.
(e) To measure force on sills or blocks in hydraulic jump for generalized design criteria for stilling basins.
(f) Apparatus calibrated. Experiments just started.

(2858) DESIGN OF WEIR FOR CONSTANT CHANNEL VELOCITY

(b) Laboratory project.

(d) Experimental and analytical; master's thesis.
(e) Investigation of weir shape to provide arbitrary approach velocities in weir channel.
(f) Apparatus completed. Experiments just started.

(2859) RESISTANCE TO FLOW THROUGH STRATIFIED GRANULAR MEDIA.

(b) Laboratory project.
(d) Experimental; master's thesis.
(e) To measure additional loss occurring at the interface of a stratified medium.
(f) Study in progress.

(2860) CALIBRATION OF MEASURING WEIRS.

(b) Agricultural Research Service, U. S. Dept. of Agriculture, in cooperation with the Minnesota Agricultural Experiment Station and the St. Anthony Falls Hydraulic Laboratory.
(d) Experimental; determination of rating curves.
(e) Models of broad-crested V-notch weirs will be constructed and test calibrated. Weirs are used for measuring runoff from experimental watersheds.

UNIVERSITY OF SOUTH CAROLINA, Civil Engineering Division.

Inquiries concerning Projects Nos. 4, 1631, and 1907 should be addressed to Dr. Harold Flinsch, Civil Engineering Div., University of South Carolina, Columbia, South Carolina.

(4) THE DEVELOPMENT OF SURFACE WAVES BY WIND.

(b) Laboratory project.
(d) General theoretical and experimental research.
(e) Research on the theories of surface wave origin and growth, on measurements in the laboratory and in nature, and on the comparative results of theory and measurement.
(f) Experimental equipment has been developed particularly for the recording of wave height and period, and is being developed for the recording of wave direction.
(h) "Report on Wave Measurement in the Gulf of Mexico", Proceedings of the Conference on Coastal Engineering Instruments, Berkeley, 1955.

(1631) THE EFFECT OF WAVES ON BEACHES.

(b) Laboratory project.
(d) General theoretical and experimental research.
(e) Research on beach slopes and contours, in the laboratory and in nature.
(g) General formulas have been developed, which are now being applied to the Carolina capes and shores.
(h) "The Effect of Waves on a Sand Beach", Harold Flinsch, Proceedings of the

Minnesota International Hydraulics Convention, p. 231, 1953, Minneapolis, Minnesota. "The Physical Development of the Gulf Coast Beaches of Western Florida, Alabama, Mississippi, and Eastern Louisiana", Harold Flinsch, Mississippi Academy of Science, 1955.

(1907) SHIP STABILITY AND ROLLING PERIOD.

(b) Laboratory project.
(d) General theoretical and experimental research.
(e) Rolling period and metacentric height relationships are studied, in the laboratory and in nature, for stationary and moving ships, in still water and under wave action.
(g) Model experiments have been assembled in a brief report. Additional data under wave action are being assembled.

SOUTHERN METHODIST UNIVERSITY, Hydraulics Laboratory.

(2861) A STUDY OF THE HEAD LOSS IN WATER TREATMENT PLANT FILTER PIPING.

(b) Laboratory project.
(c) Prof. I. W. Santry, Jr., Southern Methodist University, Dallas 5, Texas.
(d) Field investigation; undergraduate special problem.
(e) The project is to establish the magnitude on variation in head loss through various types of piping used in operating a water treatment plant stow, and filter.

(2862) RUNOFF CONDITIONS FOR LARGE URBAN AREAS.

(b) Laboratory project.
(c) Prof. I. W. Santry, Jr. Southern Methodist University, Dallas 5, Texas.
(d) Field investigation; undergraduate special problem.
(e) This project is to study the relationship between the hydrologic approach to runoff and the Rational Method for a large urban area and to study the factors affecting the runoff.

STANFORD UNIVERSITY, Department of Civil Engineering.

Inquiries concerning Projects Nos. 1944, 1945, 1946, 2863 and 2864 should be addressed to Prof. Ray K. Linsley and Projects Nos. 2150, 2151, and 2614 to Prof. John K. Vennard, Stanford University, Stanford, California.

(1944) STUDY OF METHODS OF ESTIMATING RESERVOIR EVAPORATIONS.

(b) U. S. Weather Bureau.
(d) Field investigation; applied research.
(e) A small-scale radiation integrator patterned after Cumming's model is being designed and tested.

(g) Previous field work at campus reservoir is complete. Analysis of data underway. Tentative analysis of reservoir study indicates no significant difference from conclusions of Lake Hefner study.

(1945) ESTIMATING RAINFALL INTENSITY FROM TOPOGRAPHIC PARAMETERS.

(b) U. S. Bureau of Public Roads.
(d) Statistical analysis; applied research.
(e) Hourly rainfall intensities in Northern California for a two-year period are correlated with various topographic and climatological parameters.
(f) Completed.
(g) A relation having a correlation coefficient of 0.88 and standard error of 0.77 inch per hour was derived. A rainfall intensity map for Northern California was completed.

(1946) SYNTHESIS OF HYDROGRAPHS FOR SMALL AREAS.

(b) Jointly by U. S. Bureau of Public Roads, Agricultural Research Service, and Stanford University.
(d) Theoretical and field investigation; basic and applied research.
(e) An attempt to develop a universal method for estimating the runoff hydrographs from small areas.
(f) Completed.
(g) A simplified theory for non-equilibrium conditions has been compared with experimental results taken under controlled laboratory conditions. A statistical analysis of data from several typical basins has been started.
(h) "The Mechanics of Overland Flow", C. E. Behlke, Ph.D. Dissertation 1957. (Available from University Microfilms, Ann Arbor, Mich.)

(2150) STUDY OF FLOW FROM A SLOTTED PIPE.

(b) Laboratory project.
(d) Experimental; engineer thesis.
(e) Extension of manifold port problem to continuous slot.
(g) Experimental work completed; thesis being written.

(2151) MODEL STUDY OF PETERS DAM CHUTE SPILLWAY.

(b) Laboratory project.
(d) Experimental; engineer thesis.
(e) Comparison of spillway performance and design predictions.
(g) Experimental work completed; thesis being written.

(2614) PIPE FRICTION IN UNSTEADY FLOW.

(b) Laboratory project.
(d) Experimental and analytical; Ph.D. thesis.
(e) Comparison of friction processes for steady and unsteady states.
(g) Experimental program well along and analysis begun.

(2863) FLOW THROUGH POROUS MEDIA.

(b) National Science Foundation.
(c) Prof. Byrne Perry, Dept. of Civil Engineering, Stanford University, Stanford, Calif.
(d) Theoretical and experimental; basic research.
(e) An attempt is being made to develop more general analytical methods than are now available for non-steady seepage flow with a free surface, e.g., the seepage through an earth dam.
(f) In formative stage.

(2864) GRAVITY EFFECT ON POTENTIAL FLOW WITH A FREE SURFACE.

(b) Laboratory project and Office of Naval Research.
(c) Prof. Byrne Perry, Dept. of Civil Engineering, Stanford University, Stanford, Calif.
(d) Theoretical; basic research.
(e) Extension of two-dimensional potential flow analysis to include the effect of gravity in the free surface boundary condition.
(f) In formative stage.
(g) A perturbation theory has been developed and used to calculate the coefficient of discharge for a two-dimensional sluice gate.

STEVENS INSTITUTE OF TECHNOLOGY, Experimental Towing Tank.

Inquiries concerning Projects Nos. 1410, 2155, 2390, and 2393 should be addressed to Mr. Edward V. Lewis, and concerning Projects Nos. 2391, 2616, 2617, and 2866, to Dr. John P. Breslin at Stevens Institute of Technology, 711 Hudson St., Hoboken, New Jersey.

(340) PLANING SURFACES.

(b) Office of Naval Research, Department of the Navy.
(c) Mr. Daniel Savitsky, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson St., Hoboken, New Jersey.
(d) Theoretical and experimental; basic research.
(e) A continuous series of theoretical and experimental studies of the basic hydrodynamic processes involved in the planing action of seaplane hulls and seaplane alighting gear such as hydroskis and hydrofoils. In particular, the pressure distribution, wake, main spray formation, steady and unsteady state loads are being studied.
(g) Basic studies have been completed on the pressures, wake, loads, and main spray associated with simple prismatic planing surfaces and hydroskis. Studies are currently underway on the steady and unsteady forces on surface piercing hydrofoils.
(h) Fifteen papers on the results of research conducted under the subject contract have been prepared and published. One

additional paper on the subject of main spray generated by planing hulls is currently being published.

(1410) SELF-PROPELLED TESTING.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(d) Experimental; developmental research.
(e) To determine if successful self-propelled testing can be conducted using models of less than 12-foot length, and to determine causes of scale effect in propulsion factors.
(f) Completed.
(g) Open-water tests have been completed on three different-sized models of a propeller designed by the Netherlands Model Basin for the Victory type cargo ship. Hull models of the Victory ship, 7-1/2 feet and 9 feet in length, were tested self-propelled. This work was carried out in cooperation with the Netherlands Model Basin where models 9 feet long and above are being tested.
(h) "Effect of Tank Size on Self-Propulsion Tests of a Victory Ship Model", by E. Numata, Experimental Towing Tank Report No. 635.
"Final Report on Scale Effects on Self-Propulsion Testing", by E. V. Lewis, Experimental Towing Tank Report No. 640.

(2154) INVESTIGATION OF SHIP MOTIONS.

(b) Office of Naval Research, Dept. of the Navy.
(c) Prof. B. V. Korvin-Kroukovsky, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Theoretical and experimental; basic research.
(e) The development of a method of calculation for predicting ship motions caused by head or following seas. Towing tank tests of ship forms differing widely from the forms currently used in practice, in search of considerable improvement in seakeeping qualities of ships.
(g) Derivation of coupled equations of motion and computations of motions for eight models in several wave lengths have been completed. This included the derivation of expressions for the forces and moments exerted on the ship by waves, taking into account the ship-wave interaction. These computations were compared with experimental measurements and good agreement was obtained. Five models of widely varying form and proportions were tested in regular and irregular head seas and it was shown that a reduction in displacement-length ratio leads to reduced amplitudes of motions and to higher attainable speed at sea, provided that freeboard is adequate.
(h) "An Experimental Study of the Effect of Extreme Variations in Proportions and Form on Ship Model Behavior in Waves", by E. Numata and E. V. Lewis, Experimental Towing Tank Report No. 643.
"Pitching and Heaving Motions of a Ship in

Regular Waves", by B. V. Korvin-Kroukovsky and W. R. Jacobs, paper presented at the November 1957 Meeting of the Society of Naval Architects and Marine Engineers.

(2155) INVESTIGATION OF THE SEAKEEPING QUALITIES OF SHIPS WITH PARTICULAR REFERENCE TO MOTIONS IN IRREGULAR HEAD SEAS.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(d) Theoretical and experimental; basic research.
(e) A method of producing realistic irregular long-crested waves in the model tank has been developed and applied to a study of the motions in head seas of two ship models of the same proportions but different forebody form and of a high-speed ship hull form. Results are compared with the motions calculated by recently developed methods from model performance in regular waves of a wide range of frequencies. A study of model performance over a range of headings to regular waves is in progress.
(g) Good agreement has been obtained with the three models tested between observed and predicted motions in moderate irregular seas, fair agreement in high irregular seas where non-linear effects become pronounced.
(h) "Ship Model Tests in Regular and Irregular Seas", by E. V. Lewis and E. Numata, Experimental Towing Tank Report No. 567.
"Motion, Bending Moment and Shear Measurements on a Destroyer Model in Waves", by E. V. Lewis and J. F. Dalzell, Experimental Towing Tank Report No. 656.
"New Facilities at Stevens for Research on the Seakeeping Qualities of Ships", by E. Numata, P. Spens, and A. Muley, Experimental Towing Tank Report No. 677.
"Developments at Stevens on Behavior in Irregular Waves", by E. V. Lewis, Proceedings Symposium on Behavior of Ships in a Seaway, Wageningen, Netherlands, Sept. 1957.

(2152) PLANING SURFACES IN ROLL AND YAW.

(b) National Advisory Committee for Aeronautics.
(c) Mr. Daniel Savitsky, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, New Jersey.
(d) Experimental; basic research.
(e) To conduct an exploratory investigation to define generally the nature of the flow in unsymmetrical planing, the magnitude of steady-state forces and moments, and their variation with yaw and roll angle.
(f) Completed.
(g) This project has been completed and the results are presented in ETT Report 550.
(h) "The High Speed Hydrodynamic Characteristics of a Flat Plate and 20° Deadrise Surface in Unsymmetrical Planing Conditions", by D. Savitsky, R. E. Prowse, and Dennis Lueders, ETT Report 550, March 1957.

(2156) MOTION AND STABILITY OF HYDROFOIL SYSTEMS.

(b) Office of Naval Research, Department of the Navy (DTMB Technical Supervision).
(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Theoretical; basic research.
(e) To determine the longitudinal stability characteristics of tandem hydrofoil configurations in waves, including the effects of unsteady forces and moments. The resulting motions of the system and the loadings on the foils can then be determined.
(g) A theoretical analysis of motion in smooth water has been completed. An analysis of the forces and moments in waves has been completed and tests have been made, the results of which compare well with the theory. The results have been incorporated into a study of motions in waves, which has been completed. A study has also been made of the drag of hydrofoils in unsteady motion, together with a study of the surface waves created by oscillating and translating surface pressure distributions.
(h) "The Forces Acting on Hydrofoils in Unsteady Motion",by Paul Kaplan, published in the proceedings of the Ninth International Congress of Applied Mechanics, Brussels, Belgium, 1956.
"The Waves Generated by the Forward Motion of Oscillatory Pressure Distributions", by Paul Kaplan, to be published in the proceedings of the Fifth Midwest Conference on Solid and Fluid Mechanics. Two other reports completed; to be published in the near future.

(2387) BENDING MOMENTS OF SHIPS IN WAVES.

(b) Society of Naval Architects and Marine Engineers.
(c) Mr. Edward Numata, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Experimental and analytical; applied research.
(e) Calculation of bending moments in waves, taking into account dynamic effects of ship motions and forward speed, for comparison with experimentally determined bending moments. Prediction of bending moments in irregular waves and comparison with irregular tank wave results. Extension to measurements of model bending moments at a range of headings to long crested regular waves.
(g) Fairly good agreement has been obtained between calculated and observed bending moments in head seas, giving theoretical confirmation of reduction of moments under dynamic conditions of forward speed and pitching and heaving motions.
(h) "A Study of Midship Bending Moments in Irregular Head Seas", by E. V. Lewis, Journal of Ship Research, Vol. 1, No. 1, April 1957, Society of Naval Architects and Marine Engineers.
"The Analytical Calculation of Ship Bending Moments in Regular Waves", by W. R. Jacobs, (in preparation) Experimental Towing Tank

Note No. 402.

(2389) PERFORMANCE AND DYNAMIC CHARACTERISTICS OF HYDROFOIL CRAFT.

(b) Office of Naval Research Dept. of the Navy.
(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Theoretical; applied research.
(e) To investigate the scaling of performance of hydrofoil craft of different sizes in different seas and to develop a general method for the evaluation of the stability of various hydrofoil configurations while in the preliminary design state.
(g) Three different scaling methods have been applied to representative craft, and a measure of their performance in different seas has been obtained. Motion spectra in different irregular seas were determined for each scaling and probabilities of broaching determined. Derivation of the equations of longitudinal and lateral dynamic stability has been accomplished for tandem systems employing either flat foils or dihedral surface-piercing foils.

(2390) CONTROLLED FINS FOR REDUCING SHIP PITCHING.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(d) Experimental and analytical, applied research.
(e) To determine the most desirable action of controllable fins at the bow or stern of a ship to reduce pitching in regular and irregular head seas.
(g) Analytical studies indicate that a combination of fixed fins at the bow and controllable fins at the stern seems most promising in reducing ship pitching and heaving motions; model experiments to verify these findings are in progress.

(2391) THEORETICAL STUDY OF THE HYDRODYNAMIC PRESSURE FIELD NEAR A ROTATING PROPELLER BLADE AND FORCES APPLIED TO CERTAIN SIMPLE NEARBY BOUNDARIES.

(b) David Taylor Model Basin, Bureau of Ships, Navy Department.
(d) Theoretical; applied research.
(e) Theoretical studies of the hydrodynamic field about propeller-like singularities have been undertaken because of the increasing concern of naval architects with propeller-excited ship vibration. Theoretical calculations for the force produced on a flat plate in the presence of a two-dimensional traversing vortex have been made and, in addition, the force on the same plate in the presence of a three-dimensional rotating bound vortex have been made through the use of a strip theory.
(f) Project completed; final report submitted to David Taylor Model Basin.
(g) Additional work has been done on the pressure field near a ship propeller to show the agreement between results given in

ETT Report 609 and those obtained by Garrick and Watkins for the sound pressure field on an airplane propeller.

(h) "The Pressure Field Near a Ship Propeller", by John P. Breslin, ETT Note No. 457, Oct. 1957. Submitted to Journal of Ship Research, Nov. 1957.

(2393) BENDING MOMENTS OF SHIPS IN WAVES.

(b) Bureau of Ships, Department of the Navy (DTMB Technical Supervision).
(d) Experimental and analytical; applied research.
(e) Measurements of deflection of a jointed model of a high-speed naval vessel (the third model of project 2155) to determine external bending moment underway in regular and irregular waves; comparison with analytically determined bending moments.
(g) Good agreement has been obtained between calculated and experimentally observed bending moments at low speeds in regular waves. A gradual upward trend of the range of bending moments at the midship section was observed in all wave lengths as the model's speed was increased. The waves resulting from the model's forward motion produced an appreciable increase in sagging and decrease in hogging moments at higher speeds.
(h) "Motions, Bending Moment and Shear Measurements on a Destroyer Model in Waves," by E. V. Lewis and J. F. Dalzell, Experimental Towing Tank Report No. 656.
"Introductory Remarks on Subject 8, Dynamic Forces and Moments in a Seaway", by E. V. Lewis, 8th International Towing Tank Conference, Madrid, Spain, Sept. 1957.

(2615) FORCES AND MOMENTS ON SUBMERGED BODIES BELOW WAVES.

(b) Office of Naval Research, Department of the Navy, (DTMB Technical Supervision).
(c) Dr. Paul Kaplan, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Experimental and theoretical; basic and applied research.
(e) To measure the forces and moments acting on submerged bodies moving obliquely to the crests of regular waves, and to compare the results with available theory.
(g) Slender-body theory has been applied to determine the forces and moments acting on a submerged body and also on a surface ship moving normal to the crests of regular waves. Additional work has been carried out for a submerged body moving obliquely with respect to the waves, and the results check with those obtained by more refined theories. The forces have also been found on body-appendage combinations by application of the same theory. Work is presently underway to prepare a model for the necessary experiments using the new three-dimensional wave facilities.
(h) A paper dealing with the forces when moving normal to the waves has been accepted for

publication in the Journal of Ship Research. It is also intended to submit the work dealing with oblique waves to another source for publication.

(2616) THEORETICAL STUDY OF THE TRANSIENT FORCES PRODUCED BY A SHIP PROPELLER.

(b) David Taylor Model Basin, Bureau of Ships, Navy Department.
(d) Theoretical; applied research.
(e) Theoretical study of the forces produced by a rotating propeller as represented by rotating bound vortices in the neighborhood of bodies representable by doublet distributions and source-sink distributions; analysis limited to first order effects.
(g) Formulas for the transverse vibratory force generated by an m-bladed propeller (offset from a body of revolution) have been found. Results will be published by January 1958.

(2617) THEORETICAL STUDY OF THE VIBRATORY THRUST PRODUCED BY A SHIP PROPELLER OPERATING IN THE WAKE OF A HULL.

(b) David Taylor Model Basin, Bureau of Ships, Navy Department.
(d) Theoretical; applied research.
(e) Existing methods for computing the axial, vibratory thrust produced by a ship propeller operating in a circumferentially variable wake. Assume that the forces on the blade elements are developed instantaneously, i.e., only quasi-steady forces are considered. This study will attempt to determine the influence of unsteady effects on the accuracy of the predictions of existing methods.
(g) The study completed. Report in preparation. Results of one calculation show a considerable reduction in the vibratory thrust and torque through the use of unsteady theory as compared to the quasi-steady method.

(2865) EFFECT OF SPEED AND FULLNESS ON HULL BENDING MOMENTS IN WAVES.

(b) American Bureau of Shipping.
(c) Mr. Edward Numata, Experimental Towing Tank, Stevens Institute of Technology, 711 Hudson Street, Hoboken, N. J.
(d) Experimental, applied research.
(e) To determine to what extent, if any, different longitudinal strength standards should be adopted for ships of different fullness and service speeds. The hull midship bending moments of three models with block coefficients ranging from 0.68 and 0.80 will be determined in regular and irregular head and following seas.

(2866) AN ANALYTIC STUDY OF THE PRESSURE FIELD NEAR COUNTER-ROTATING PROPELLERS.

(b) David Taylor Model Basin, Bureau of Ships, Navy Department.
(d) Theoretical; applied research.

(e) In regard to the problem of mitigating the vibratory hydrodynamic forces applied by a ship propeller, the free-space field of a counter-rotating propeller is to be studied. The study is to be divided into two parts: (1) The effects from each propeller are summed as though they were independent; (2) an approximate treatment of the effect of blade interaction will be attempted.
(f) Suspended awaiting approval to proceed.
(g) Not available.

UNIVERSITY OF TENNESSEE, Hydraulic Laboratory, Department of Civil Engineering.

Inquiries concerning Projects Nos. 2159, 2619, and 2867 should be addressed to Dr. Harry H. Ambrose, Department of Civil Engineering, University of Tennessee, Knoxville 16, Tennessee.

(2159) DISCHARGE COEFFICIENTS FOR TAINTOR GATES ON SPILLWAYS.

(b) Cooperative with the Tennessee Valley Authority.
(d) Experimental; for master's thesis.
(e) Discharge coefficients were determined for a generalized model of a taintor gate on a spillway. The effect of the trunnion location as well as that of the relative head and of the relative gate opening was investigated.
(f) Experimental work completed, preparation of thesis suspended temporarily.

(2619) BOUNDARY ROUGHNESS EFFECTS UPON TURBULENT FLOW.

(b) National Science Foundation.
(d) Experimental; basic research.
(e) Measurements of velocity distributions and head losses for turbulent flow in a pipe with artificial boundary roughness are being made to assess the specific effects of certain characteristics of the roughness-element geometry (relative height, relative spacing, continuous or discrete in form). It is anticipated that comparative tests for the same roughness patterns will be made in an open flume.
(f) Tests have been completed upon a series of peg-type roughnesses which allow direct comparison of the results with data obtained previously for geometrically similar roughness patterns at half-scale. Tests are currently underway with ring-and groove-type patterns which will have the same relative height and relative spacings as the peg-type patterns.
(g) Velocity distributions and resistance-coefficient curves are similar for peg-type patterns which are geometrically similar with respect to longitudinal spacing. A less important quantitative effect is involved in the size of the elements. Longitudinal spacing determines which of two radically different roughness actions will

take place at a given Reynolds number for the peg-type patterns.
(h) "An Experimental Study of Turbulent Flow in Pipes with Geometrically Similar Roughness Patterns", by James T. Price, Univ. of Tennessee, thesis for the Master's Degree available from the University Library on an inter-library loan basis.

(2867) A MICROMANOMETER FOR WATER SYSTEMS.

(b) Laboratory project.
(d) Experimental; applied research.
(e) In connection with Project (2619) it was found necessary to develop a very sensitive manometer for measuring head differences for the flow of water. Several types of gages were investigated for accuracy, sensitivity, time response, and simplicity of operation.
(f) Completed.
(g) A modification of the zero-displacement micromanometer described by E. Kovacic, Yugoslavia, in La Houille Blance, Vol. 10, No. 2, p. 177, was found to give excellent results. Kerosene was used as the gage fluid with a small bubble of air as the plug. Response was good for differences in head as small as 0.0001 feet of water.

TEXAS A AND M COLLEGE, Department of Oceanography and Meteorology.

(2621) WAVE FORCE EXPERIMENTS ON 16-INCH AND 30-INCH DIAMETER PILES IN 40-FEET MEAN WATER DEPTH.

(b) Gulf Oil Corporation.
(c) Mr. C. L. Bretschneider, original Project Supervisor; Dr. B. W. Wilson, Project Supervisor from Sept. 1955, Texas A and M College, College Station, Texas.
(d) Field investigation, experimental and analytical; basic and applied research.
(e) Determination of actual wave forces on vertical cylindrical test piles of 16-inch and 30-inch diameter in mean water depth of 40 feet at an oil platform 40 miles from the Louisiana coast near Eugene Island. Each test pile was attached to the oil platform at two reaction points above water level; horizontal and vertical reactions to wave pressures were measured electronically and results analyzed in relation to physical characteristics of the waves.
(f) Initiated September 1952; completed July 1957.
(g) Analysis initially attempted to determine values of drag coefficient and coefficient of virtual mass for selected wave data on basis that wave force mainly comprises drag and inertial components. In a second approach numerical filtering techniques employing high speed digital computers were used to separate out harmonic components in the waves and wave forces and

assess the correlating coefficients. Data for the 16-inch diameter pile were finally evaluated by determining drag and inertial coefficients from the maximum range of total wave force for selected waves. Data for the 30-inch diameter pile were analyzed by correlating an overall resistance coefficient with the Reynolds and Iversen Numbers applicable to the fluid flow round the pile; also by evaluating the corresponding drag and inertial coefficients. Numerical prediction techniques, utilizing high speed digital computers, were used to determine applicable water particle velocities and accelerations from the surface observations.

(h) "Analysis of Wave Force Measurements on 16-inch and 30-inch Diameter Piles in 40-Feet Mean Water Depth in the Gulf of Mexico", by B. W. Wilson, Tech. Report No. 55-4, Texas A and M Res. Fdn., Oct. 1956.
"Evaluation of Drag and Inertial Coefficients from Maximum Range of Total Wave Force", by C. L. Bretschneider, Tech. Report No. 55-5, Texas A and M Res. Fdn., May 1957.
"IBM Computer Procedures and Special Methods Used in Analysis of Wave Force Data -- 30-inch Diameter Test Pile", by B.W. Wilson, Tech. Report No. 55-6, Texas A and M Res. Fdn., June 1957.
"Results of Analysis of Wave Force Data -- Confused Sea Conditions Round a 30-inch Diameter Test Pile, Gulf of Mexico", by B. W. Wilson, Tech. Report No. 55-7, Texas A and M Res. Fdn., July 1957.

(2623) WAVE STATISTICS FOR THE GULF OF MEXICO.

(b) Beach Erosion Board, Corps of Engineers, U.S. Army.
(c) Mr. C.L. Bretschneider, original Project Supervisor; Dr. B. W. Wilson, Project Supervisor from June, 1955.
(d) Field investigation; applied research.
(e) To determine the significant wave heights and periods in different water depths at five locations in the Gulf of Mexico (Brownsville, Caplen, Burrwood, Apalachicola, and Tampa) for hindcasts based on statistical weather data over the Gulf covering a three-year period.
(f) Initiated June 1954; completed May 1957.
(g) Wind velocities, wind duration, fetch and decay distances for hindcasting wave characteristics by the Sverdrup-Munk-Bretschneider method were determined from twelve-hourly synoptic weather charts for the Gulf of Mexico. Hindcasts of swell were made for five deep water locations off Brownsville, Texas; Galveston, Texas; Burrwood, Mississippi; Apalachicola, Florida; and Tampa, Florida. Frequency diagrams of wave and wind conditions for these areas were developed. A separate study was made of wave conditions at the five stations during passage through the Gulf area of typical severe hurricanes occurring between 1900 and 1950. A moving fetch, variable wind forecasting technique was used to perform the hindcasts. Statistical data on

frequency of occurrence and magnitudes of hurricane waves were compiled.

(h) "Wave Statistics for the Gulf of Mexico off Tampa, Florida", by C.L. Bretschneider and R. D. Gaul, Tech. Memo No. 89, Beach Erosion Board, Oct. 1956.
"Hurricane Wave Statistics for the Gulf of Mexico" by B. W. Wilson, Tech. Memo No. 98, Beach Erosion Board, June 1957.

(2868) INVESTIGATION OF STORM SURGES ALONG THE SOUTH SHORE OF NEW ENGLAND.

(b) Beach Erosion Board, Corps of Engineers, U. S. Army.
(c) Prof. Robert O. Reid, Project Supervisor.
(d) Numerical analysis; applied research.
(e) The hydrodynamic equations for a one-dimensional forced surge in water of variable depth are utilized in evaluating the generation of storm surges on the continental shelf off Narragansett Bay. Both graphical and numerical techniques have been utilized in integrating the basic equations. Numerical methods using high speed computers are being utilized in solving the problem of propagation of the surge into Narragansett Bay. Bottom friction and wind stress are considered in this analysis.
(g) A numerical procedure for computation of water level changes in coastal bays and estuaries has been utilized for estimating the potential storm surges in Narragansett Bay, Long Island Sound, and Buzzards Bay for a selected design hurricane. The numerical calculations are based upon the quasi-linear, one-dimensional equations of motion and continuity. In the numerical evaluation of storm surge generation over the continental shelf, the equations are modified so as to allow for long-shore dispersion of energy in an approximate manner. The calculations for the modification of the surge as it enters the bay include the provision for energy loss by bottom friction and energy gain by wind stress over the bay. In the calculations for Narragansett Bay, the latter is regarded as a network of interconnecting channels, each of which are considered to be of uniform width and depth. The method of calculation has been "calibrated" by using the known data for the September 21, 1938, hurricane as a control. The calibration involves the selection of appropriate friction, reflection, and refraction conditions for the system, which will allow the best fit of the numerical results with the control data.
(h) "Dynamic Storm-Tide Potential: Approximate Response of Water Level on a Sloping Shelf to a Wind Fetch Which Moves Directly Toward Shore", by R. O. Reid, Tech. Memo No. 83, Beach Erosion Board, June 1956.
"Modification of the Quadratic Bottom-Stress Law for Turbulent Channel Flow in the Presence of Surface Wind Stress", by R. O. Reid, Tech. Report No. 2 (Ref. 56-27T), Texas A and M Res. Fdn., Oct. 1956.

Final report in preparation.

(2869) INVESTIGATION OF PROBLEMS ASSOCIATED WITH PREDICTION OF STORM-INDUCED WATER LEVELS.

(b) U. S. Weather Bureau, Dept. of Commerce.
(c) Prof. R. O. Reid, Project Supervisor.
(d) Theoretical with verification from existing data; applied and basic research.
(e) The generation of two-dimensional surges in deep water for a moving radially symmetric storm, including the effects of the earth's rotation, is being investigated analytically. In addition the modification and generation of surges on a continental shelf of variable depth is being investigated numerically, with the aim of comparing computed water levels at shore with those observed for past hurricanes along the U. S. coast (East coast and Gulf coast areas).
(g) Analytical and numerical methods of evaluation of storm surges for deep water and coastal waters are being investigated. The work underway at present includes the analytical investigation of two-dimensional waves on a continental shelf, taking Coriolis force into account. An investigation of the free modes has been carried out, and the forced response is currently being investigated.
(h) "A Forced Wave Caused by Atmospheric Disturbances in Deep Water", by K. Kajiura, Tech. Report 133-1 (Ref. 56-26T), Texas A and M Res. Fdn., October 1956. "Forced and Free Surges in a Narrow Basin of Variable Depth and Width: A Numerical Approach", by R. O. Reid, Tech. Report (Ref. 57-25T), Texas A and M Res. Fdn., Aug. 1957.

(2870) MODEL STUDY OF SURGE ACTION IN A PORT.

(b) Office of Naval Research, Project NR 083-036, Contract N7onr-48702.
(c) Dr. B. W. Wilson, Principal Investigator (Dr. D. F. Leipper, Project Supervisor).
(d) Experimental; basic and applied research.
(e) To collate results and conclusions from a model study of long period wave action in a harbor (Gulf of Mexico).
(g) Model experiments have been completed and results analyzed. Final reporting of results remains.

(2871) DIFFRACTION OF PLANE GRAVITY WAVES CAUSED BY A HORIZONTALLY SUBMERGED CIRCULAR CYLINDER.

(b) Department project.
(c) Prof. R. O. Reid, Chairman (Faculty Committee).
(d) Theoretical and experimental; basic and applied research; for Ph. D. thesis.
(e) To investigate experimentally and theoretically the effects of a stationary horizontal circular cylinder submerged to a given level in different depths of water upon the passage of plane gravity waves around it and normal to its length.

(g) This project has necessitated construction of a special wave tank, wave generator and pressure recording devices for registering wave pressure anomalies. Experimental data has been collected and is currently being analyzed.

(2872) LONG WAVES GENERATED BY ATMOSPHERIC DISTURBANCES IN AN OPEN OCEAN.

(b) U. S. Weather Bureau, Con. No. CWB-9071.
(c) Prof. R. O. Reid, Project Supervisor and Chairman (Faculty Committee).
(d) Theoretical; basic research; Ph. D. thesis.
(e) To determine the nature of long waves generated in an open ocean by travelling atmospheric disturbances.
(g) Theoretical investigation of the influence on the water surface of a radially symmetric storm, such as a hurricane or typhoon, suddenly generated and advancing at a uniform speed over water of uniform depth in a two-layered ocean of infinite expanse has been completed in the first phase.

(2873) COMPUTATION OF DESIGN STORM TIDE FOR THE NEW YORK BAY AREA.

(b) Beach Erosion Board, Corps of Engineers, U. S. Army and New York Division, Corps of Engineers.
(c) Dr. B. W. Wilson, Project Supervisor.
(d) Numerical analysis, applied research.
(e) This project represents an extension of the work performed for the New England area, aimed at defining the critical storm tides that could develop in the New York area from severe hurricane attack. The methods to be used are numerical, utilizing the facilities of high-speed digital computers. Three phases are planned: (1) Investigation of two-dimensional effects of the storm surge on the continental shelf at the bay mouth; (2) computation of storm tide in New York Bay for the conditions of the hurricane of September 14, 1944; (3) computation of storm tides for a design hurricane moving at two possible speeds along a northwest path into New York Bay.

UNIVERSITY OF TEXAS, Department of Civil Engineering.

Inquiries concerning Projects Nos. 948, 2162, 2396, 2397, 2629, and 2873, should be addressed to Dr. Walter L. Moore, Dept. of Civil Engineering, University of Texas, Austin 12, Texas.

(948) DIFFUSION OF A TWO-DIMENSIONAL SUBMERGED JET.

(b) Laboratory project.
(d) Basic experimental.
(e) An investigation is being made of the diffusion of momentum in a two-dimensional jet as influenced by the proximity to a plane boundary. Apparatus was constructed

for measuring the velocity field in the diffusion region of an air jet 0.05 feet thick and 3.0 feet wide with a plane parallel boundary at various distances from the axis of the jet.

(f) Inactive. (One phase of project is nearly complete.)

(g) Measurements are complete covering a range of boundary distance from 0 to 1.8 ft. Results indicate that the boundary has a stabilizing influence and tends to reduce the rate of diffusion. As the distance to the plane boundary is increased the diffusion increases. Mean flow streamlines obtained in the diffusion region defined a stable eddy between the jet and the boundary and indicated a linear spread of the jet downstream from the eddy. Velocity profiles in the zone of linear spread were all reducible to a single dimensionless curve. Measurements of static pressure in the stable eddy indicated significant negative pressures according to a systematic pattern. Checks of momentum and energy flux gave reasonable values.

(h) Unpublished annual report to National Science Foundation is available on two weeks loan.

(2161) CHARACTERISTICS OF A HYDRAULIC JUMP AT AN ABRUPT CHANGE IN BOTTOM ELEVATION.

(b) University of Texas Research Institute and Bureau of Engineering Research.

(c) Prof. C. W. Morgan, Dept. of Civil Engrg., Univ. of Texas.

(d) Experimental.

(e) Experimental determinations are made of the flow characteristics at two-dimensional channel drops and rises. The velocity distribution and surface profile will be determined throughout the length of the jump for various relative changes in bottom elevation. The longitudinal location of the jump in relation to the change in bottom elevation will be varied over a broad range in distinction to previous related investigations in which relative location of the jump was held constant.

(g) Results for the abrupt drop are complete and have been published. For a given entering Froude No. lying between 2 and 8 three types of jump may form, the type and its longitudinal location depending only on the relative downstream depth. The velocities near the bottom below the drop are always less than the mean velocity in the downstream channel for the jump type of maximum height. Experimental measurements have been made on the related investigation for an abrupt rise.

(h) "The Hydraulic Jump at an Abrupt Drop", by W. L. Moore and C. W. Morgan, Proceedings, A.S.C.E., Vol. 83, No. HY6, pp. 1449-1-21, Dec. 1957.

(2162) HYDROLOGIC STUDIES, WALLER CREEK WATERSHED.

(b) Cooperative with U. S. Geological Survey.

(d) Field investigation; applied research.

(e) Measurements of rainfall and runoff for a 4 square mile and 2 square mile portion of the Waller Creek watershed are being made to provide basic information for estimating runoff from small urban watersheds in the southwest area. Two streamflow stations and a rain gage net are in operation. Studies of the correlation between runoff, rainfall, and the characteristics of the drainage basin are being made by various proposed methods to serve as a base for comparison with the data as it is collected from the stream.

(h) Master's thesis on analysis.

(2396) RESISTANCE OF PIERS IN FREE SURFACE FLOW.

(b) Laboratory project.

(d) Theoretical and experimental (thesis).

(e) An investigation is being made of the drag resistance of piers as a function of shape, relative submergence, spacing, and Froude numbers. The pier resistance is being correlated with the head loss for flow in a channel.

(g) A phase of the investigation has been completed for Froude numbers less than 0.5 with cylindrical piers at various submergence and spacing. An investigation of the resistance of H sections piers at various orientations and longitudinal spacings has been completed. Another phase has been completed which demonstrates that the velocity gradient along a cylindrical pier affects the drag coefficient. The local drag coefficient decreases along the pier in the direction toward the end of the pier where the velocity is high. The reduction in drag coefficient is related to a dimensionless measure of the velocity gradient along the cylinder.

(h) "The Relationship Between the Head Loss at Bridge Piers and the Drag Resistance of the Piers", by Jerry Garrett, M.S. Thesis, January 1956.
"The Effect of a Velocity Gradient on the Drag Coefficient for Circular Cylinders", by Frank D. Masch, M.S. Thesis, August 1957.

(2397) EFFECT OF UPSTREAM DEVELOPMENT ON THE RUNOFF FROM SMALL WATERSHEDS IN THE SOUTHWEST.

(b) Laboratory project.

(d) Field investigation (thesis).

(e) For a selected watershed rainfall and runoff relations before the period of upstream development are being analyzed. The relations obtained for this period will be applied to the rainfall records after the upstream development and the predicted runoff compared with the actual runoff.

(g) Sources of data have been located, the available information tabulated, and a method of evaluating the runoff devised that appears to be reasonable.

(2629) A MECHANICAL TURBULENCE INDICATOR FOR LIQUIDS.

(b) Bureau of Engineering Research, University of Texas.
(d) Experimental instrument development.
(e) There is need for a relatively simple device to give a quantitative measure of the degree of turbulence in a flowing fluid. Electrical instruments commonly measure the root mean square of the turbulent fluctuations as an indication of the intensity. The instrument being developed measures the maximum turbulent fluctuation as an indication of the intensity. The instrument is similar to a 1/2 inch diameter Prandtl velocity tube except that it has two stagnation openings; the conventional one which gives the mean stagnation head and an additional one which leads through a sensitive check valve and accumulator to a manometer tube. The check valve and accumulator elements are located in the tube less than 3/8 of an inch from the stagnation opening to minimize inertia effects.
(g) The instrument has been built and a membrane for the check valves developed. Turbulence data measured in a hydraulic jump and in a circular jet appear reasonable in relation to published data for similar flows. Calibration of the instrument is being made with a controlled pressure fluctuation at various frequencies.

(2874) AN INVESTIGATION OF THE SCOUR RESISTANCE OF COHESIVE SEDIMENTS.

(b) Bureau of Engineering Research, University of Texas.
(d) Analytical and experimental (laboratory).
(e) An attempt is being made to evaluate the scour resistance of cohesive sediments by means of a standardized scour test. An approximate analysis indicated that a nominal value of the shear stress at sediment surface could be obtained for radially outward flow between a circular disk and the sediment sample. An apparatus was constructed with which the net force on the circular disk and the rate of flow could be adjusted to desired values and accurately measured. Preliminary tests have been made on several molded samples and the rate of penetration of the disk measured as a function of the rate of flow and net disk load. It is hoped that as a minimum an arbitrary scale can be set up for comparing the scour resistance of various cohesive sediments and that possibly this scale can be related to flow parameters for other situations and to other measureable soil properties.

THE STATE COLLEGE OF WASHINGTON, The R. L. Albrook Hydraulic Laboratory.

Inquiries concerning Projects Nos. 1689, 2165, 2166, 2398, 2630 to 2634 incl. and 2875 to 2879 incl., should be addressed to Dr. E. Roy Tinney, Head, The R. L. Albrook Hydraulic Laboratory, Division of Industrial Research, State College of Washington, Pullman, Washington.

(1689) STUDY OF FLUID FLOW IN PIPE NETWORKS.

(b) Designers and managers of water and gas distribution systems.
(d) Analyses by analogue and digital computers.
(e) Studies of distribution systems by the McIlroy Pipeline Network Analyzer. Analyses have been made of the water supply systems for over 30 cities. Gas systems have also been analyzed as well as the cooling system of a large hydro plant. An analysis is being developed whereby some of the problems not readily solvable by the McIlroy Analyzer can be carried out on an IBM 650 digital computer.

(2165) THE INFLUENCE OF LOGGING OPERATIONS ON RUN-OFF FROM PRECIPITATION.

(b) Laboratory project.
(d) Analytical with field investigation.
(e) The run-off from water sheds on which extensive logging has been made is being conducted to determine the correlation between run-off and logging in regions where the rainfall is heavy and regrowth rapid.
(f) Inactive.
(h) "The Effect of Logging on the Run-Off of a Stream Near the Columbia River Estuary", presented at the Seattle Conference of the American Geophysical Union, November 1956. This paper has been prepared for publication.

(2166) NOXON RAPIDS HYDROELECTRIC DEVELOPMENT.

(b) Ebasco Services, Incorporated, for Washington Water Power Company.
(d) Experimental; design.
(e) A 1:50 model of this development has been constructed to study cofferdam construction procedures, spillway capacity, training wall design, diversion, and tailrace excavation. A 1:70, two dimensional model of the spillway has been made to study various dentated sills and a 1:30 model of the penstock intake has been built to study entrance losses. A distorted model, vertical scale 1:100 and horizontal scale 1:250, was built of the Clark Fork River to determine the scour pattern in the realigned river for a new bridge crossing.
(f) Completed.
(h) Final report prepared by Ebasco Services, Inc.

(2398) PLEASANT VALLEY HYDROELECTRIC DEVELOPMENT.

(b) Ebasco Services, Incorporated for the Pacific Northwest Power Co.
(d) Experimental; design.
(e) A 1:50 model of a 534 ft high arch dam has been made to study conditions at the base of the free over-fall. Of particular importance are the waves and surges along the powerhouse walls, the design of outlet works, and the rating of the free over-fall spillway. A pilot model, at a scale of 1:175, has been constructed to aid in

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selecting the best overall design.

(f) Inactive.

(2630) BROWNLEE HYDROELECTRIC DEVELOPMENT.

(b) International Engineering Company for the Idaho Power Company.
(d) Analytical and experimental.
(e) A 1:70 comprehensive model of the complete development has been constructed. Detailed tests have been made on the intake channel, the low level outlets, the spillway chute, and the spillway bucket. Comparisons have been made on the advantages of flip buckets, cascade type spillways, and a partially submerged horizontal apron. Particular attention has been given to eliminating erosion occurring at the toe of the dam. In addition, a 1:35 model of the spillway crest and low level outlets has been constructed in a 4 ft wide glass sided flume. Studies have been made of the pressures on the crest, on the piers, and on the roof, invert and sides of the low level outlets. Tests have also been made to determine the discharge capacity and to determine the most suitable method of eliminating the disturbance at the junction of the outlet and spillway crest flows.
(f) Completed.
(h) Final report prepared by the International Engineering Company.

(2631) ROCKY REACH HYDROELECTRIC DEVELOPMENT.

(b) Chelan County Public Utility District No.1.
(d) Experimental; design.
(e) A 1:75 model 109 ft by 40 ft has been constructed of 7500 ft of the Columbia River to study construction phases and the operation of the complete development of the Rocky Reach site. Studies have been completed on the cofferdam layouts and tests are now underway on the operation of the spillway and fishway entrances. In addition, a 1:44.9 scale model of two bays of the spillway has been constructed in a large glass sided flume to determine specifically the design of baffles on the apron and nappe splitters on the ogee.
(h) Status reports to the client.

(2632) PRIEST RAPIDS PENSTOCK GATE STUDIES.

(b) Pacific Coast Engineering Company.
(d) Experimental; design.
(e) A 1:18 model of fixed wheel intake gates for the Priest Rapids Hydroelectric Project has been constructed to determine the hydraulic downpull for several lip designs. A generalized study has also been made to investigate various designs of intake gates with a view toward a more economical design of gates and gantry cranes.

(2633) WATER WALL FOR ATOMIC REACTORS.

(b) General Electric Company, Hanford Atomic Products Operation.
(d) Experimental; design.

(e) A 1:3 model of a large manifold has been constructed to determine the hydraulic stability, flow patterns, and pressure losses.

(2634) KARNAFULI HYDROELECTRIC PROJECT.

(b) International Engineering Company for the Government of Pakistan.
(d) Experimental; design.
(e) Model investigation at a scale of 1:70 of the spillway of the Karnafuli project. Particular attention has been paid to the discharge capacity of the spillway, to the action in the stilling pool, and to the hydraulic behavior of the diversion channel.
(h) Final report being prepared.

(2875) OXBOW HYDROELECTRIC DEVELOPMENT.

(b) International Engineering Company.
(d) Experimental; design.
(e) A 1:72 model of the rock fill dam and the two spillway crests and chutes have been constructed to study the optimum alinement of the spillway axes. Attention is also being focused on the approach channels and on the flow patterns in the neighborhood of the fish trap.

(2876) BROWNLEE FISH BARRIER.

(b) Idaho Power Company.
(d) Analytical and experimental.
(e) An analytical development is being pursued to determine the forces and three-dimensional shape of a 2800 ft long and 120 ft deep fish barrier that is proposed for installation in the Brownlee hydroelectric development reservoir. The solution of the differential equations developed will be carried out on an IBM 650 digital computer. In order to check the theory, a 1:150 scale model of the fish barrier is being built. The model will also be used to design the anchorage system.

(2877) FISHWAY MODELS.

(b) Chelan County PUD No. 1.
(d) Experimental; design.
(e) Two 1:12 scale models have been built of the fish transportation facilities for the Rocky Reach Hydroelectric Development. One model is of the upper end of the ladder and orifice section of the facility and the second model is of the trifurcation at the junction of the powerhouse and spillway.

(2878) HYDRODYNAMICAL STUDIES.

(b) Laboratory project.
(d) Theoretical.
(e) A mathematical analysis of segmental flip buckets has been developed using free streamline theory. The analysis shows the relation between the dimensions of the bucket, the thickness of the nappe, the face angle of the dam, and the exit

angle of the jet. The evaluation of the integrals arising from the conformal transformation is being made using an IBM 650 digital computer.

(2879) HYDRAULICS OF LEVEL IRRIGATION.

(b) Laboratory project cooperative with the Department of Agricultural Engineering.
(d) Theoretical and experimental.
(e) An analysis is being developed to define the rate of advance and recession of the water front on a level irrigation border taking into account the infiltration. A tilting flume 75 feet long, 3 feet wide and 2 feet deep is being erected with a mechanical apparatus to simulate infiltration.

UNIVERSITY OF WASHINGTON, Dept. of Civil Engineering.

(2636) RATE OF FLOW THROUGH HORIZONTAL AND SLOPING SCREENS AT END OF FLUME WITH RESPECT TO DISTANCE ALONG THE SCREEN.

(b) Laboratory project.
(c) Dr. Eugene P. Richey, University of Wash., Seattle 5, Washington.
(d) Experimental and theoretical; for master's thesis.
(e) An experimental investigation of the actual behavior of the energy change through the screen by the pressure drop coefficient or screen coefficient, and to measure the actual depths to furnish verification of a theoretical of the surface profile.
(f) Completed.
(g) Very good correlation was found between the analytical and the experimental results, except when the water depth in the channel is less than 0.2 feet.
(h) Thesis by Ling-Sheng Miao is on file at the University of Washington Library.

(2637) INFLUENCE OF PROXIMITY OF ORIFICES TO EACH OTHER ON THEIR DISCHARGE.

(b) Laboratory project.
(c) Dr. Joseph C. Kent, University of Wash., Seattle 5, Washington.
(d) Experimental; for master's thesis.
(e) Discharge of orifices placed close together compared to similar orifices placed remotely.

(2880) MODEL STUDY OF PUMP SUCTION CHEST FOR ARD-37 AUXILIARY FLOATING DRYDOCK.

(b) Project conducted for W. C. Nickum and Sons, Architects and Engineers.
(c) Prof. Harold K. Moritz and Prof. William M. Miller, University of Washington, Seattle 5, Wash.
(d) Experimental; for design.
(e) An experimental study to determine flow distribution into the pump, and pressures on the interior walls with particular attention to possibility of cavitation,

made on a plexiglas model 1:6 ratio, under various conditions of manifolding.
(f) Completed.
(g) Favorable to contemplated design.
(h) Results are contained in 53 page report submitted to sponsor.

(2881) TO INVESTIGATE THE PRESSURE FIELD INDUCED ON A FLOATING BRIDGE BY THE PASSAGE OF A LARGE VESSEL.

(b) Washington Toll Bridge Authority.
(c) Dr. Eugene P. Richey, University of Wash., Seattle 5, Washington.
(d) Theoretical.
(e) A theoretical analysis was made of the pressures that would develop on the open faces of a floating bridge due to the passage of a large vessel moving at a moderate speed. A related study was made of the hydraulic forces to be overcome during the opening cycle of the floating spans.
(f) Completed.
(g) Results contained in report to sponsor.

(2882) SALMON FATIGUE STUDY.

(b) State Fisheries Dept.
(c) Dr. DeLacy, Dept. of Fisheries, and Dr. Joseph C. Kent, Univ. of Washington, Seattle 5, Wash.
(d) Field investigation.
(e) To test swimming speeds of salmon as they migrate up the Columbia River.
(h) Report in preparation.

(2883) ENERGY DISSIPATION MANIFOLD FOR THE TOLT RIVER PIPELINE.

(b) City of Seattle, Board of Public Works.
(c) Dr. Eugene P. Richey and Prof. H. S. Strausser, Univ. of Wash.,Seattle 5, Wash.
(d) Experimental; for design.
(e) An attempt to determine the mode of energy dissipation achieved by introducing high velocity pipe flow into a large conduit in a tangential fashion.

(2884) SPILLWAY AND ENERGY DISSIPATION SYSTEM FOR THE TOLT RESERVOIR DAM.

(b) City of Seattle, Board of Public Works.
(c) Dr. Eugene P. Richey and Prof. H. S. Strausser, Univ. of Wash.,Seattle 5, Wash.
(d) Experimental; for design.
(e) The hydraulic performance of the different design arrangements for the proposed Tolt River Reservoir Dam was investigated on a model scale. Features of particular interest were the flow conditions at the entrance to the spillway and the diversion of the jet from the spillway back into the natural river channel.
(g) Design was completed on basis of tests.

(2885) THE LADDER AND POWERHOUSE COLLECTION CHANNEL: PART OF THE UPSTREAM MIGRANT SYSTEM, MAYFIELD FISH FACILITIES.

(b) City of Tacoma, Dept. of Public Utilities,

Light Division.

(c) Dr. Eugene P. Richey, Univ. of Washington, Seattle 5, Wash.

(d) Experimental; for design.

(e) The sponsor's design and model of the collection system for upstream migrants was tested through a wide range of operating conditions. Features requiring special attention were the methods of supplying auxiliary water to the system and various types of weirs and baffles.

(f) Completed.

(g) Results contained in report to sponsor.

(2886) THE SKIMMER: A PART OF THE DOWNSTREAM MIGRANT SYSTEM, MAYFIELD FISH FACILITIES.

(b) City of Tacoma, Dept. of Public Utilities, Light Division.

(c) Dr. Eugene P. Richey, Univ. of Washington, Seattle 5, Wash.

(d) Experimental.

(e) A study was made of a 1:3 model of the hydraulic performance of a device designed as part of the downstream migrant system for the Cowlitz Dam at present under construction. The purpose is to reduce the initial quantity of water needed for attracting fish to a level deemed adequate for subsequent transportation of the fish.

(g) Results contained in report to sponsor.

(2887) COMPARISON OF RIGID PLATE WAVE GENERATOR WITH FLEXIBLE PLATE WAVE GENERATOR.

(b) Engineering Experiment Station, Univ. of Washington, Seattle 5, Wash.

(c) Dr. Joseph C. Kent, Univ. of Washington, Seattle 5, Wash.

(d) Experimental, theoretical; master's thesis.

(e) Performances of flexible plate wave generator analyzed and compared with rigid plate wave generator.

(2888) ANALYSIS OF STATUS OF LONG-TERM PREDICTION OF STREAMFLOW.

(b) Laboratory project.

(c) Prof. T. H. Campbell, 201 More Hall, Univ. of Washington, Seattle 5, Wash.

(d) Experimental; basic research.

(e) Comparative study of approaches which have been proposed for long-term forecasting of streamflow, with a view to determining usefulness of each. This study probably will continue over a long period of time.

WORCESTER POLYTECHNIC INSTITUTE, Alden Hydraulic Laboratory.

Inquiries concerning Projects Nos. 1963, 2411, 2638, 2640 to 2645, incl., 2647 and 2888 to 2896, incl., should be addressed to Prof. L. J. Hooper, Director, Alden Hydraulic Laboratory, Worcester Polytechnic Institute, Worcester 9, Mass.

(1963) METER CALIBRATION.

(b) Foxboro Co.

(d) Experimental; for design.

(e) Weighing tank calibration of 1, 2, 4, 6, 8, 10, 12" Magnetic flow Meters.

(2411) METER CALIBRATION.

(b) Foster Engineering Co.

(d) Experimental; for design.

(e) Calibration of several designs of Gentile meters in 4 inch to 18 inch diameter range.

(2638) METER CALIBRATION.

(b) Penn Instrument Division, Burgess-Manning Company.

(d) Experimental, for design.

(e) Calibration of several types of flow meters in 4 inch to 20 inch diameter range.

(2640) BAKER RIVER HYDROELECTRIC DEVELOPMENT.

(b) Stone and Webster Engineering Corp.

(d) Experimental; for design.

(e) A 1/50 scale model of the intake structure was constructed in the 3-foot glass sided flume including the intake, transition and twin penstocks. The tests were made to determine the flow conditions in the transition and intake.

(f) Completed.

(2641) BAKER RIVER HYDROELECTRIC DEVELOPMENT.

(b) Stone and Webster Engineering Corp.

(d) Experimental; for design.

(e) A 1/40 scale model including the spillway, chute and section of the river bed downstream were set up in a wooden flume. The tests involved determination of discharge coefficient and gate calibration, design of walls on chute and the position of downstream protection.

(f) Completed.

(2642) PELTON HYDROELECTRIC DEVELOPMENT.

(b) Ebasco Services, Inc.

(d) Experimental, for design.

(e) A 1/60 model of a section of the arch dam, the spillway, the spillway chute, the powerhouse and a section of the river bed was constructed. The flow for a range of discharges was studied.

(f) Completed.

(2643) NORTH FORK HYDROELECTRIC DEVELOPMENT.

(b) Ebasco Services, Inc.

(d) Experimental; for design.

(e) A 1/60 model including the arch dam, powerhouse, sluice gates, spillway, spillway chute and a section of the river bed was constructed. Studies were made of the performance of various flow conditions.

(f) Completed, report being written.

(2644) ROCKY REACH HYDROELECTRIC DEVELOPMENT.

(b) Stone and Webster Engineering Corp.

(d) Experimental, for design.
(e) A 1/60 wooden model of a section of spill-
way including 3-1/2 inch gates was con-
structed. Flow studies were made of vari-
ous aprons, walls and gates.
(f) Completed, report being written.

(2645) ELMHURST DAM - WATER SUPPLY.

(b) Thomas H. Wiggin.
(d) Experimental, for design.
(e) A 1/50 model of the original spillway,
section of dam, new spillway and river bed
downstream was constructed. Flow studies
were conducted on walls, deflectors and
energy dissipators.
(f) Tests in progress.

(2647) SHERMAN HYDROELECTRIC DEVELOPMENT.

(b) New England Power Service Co.
(d) Experimental; for design.
(e) A 1/40 model of the dam, spillway, spillway
chute, powerhouse and river bed are being
constructed. Studies will include means
of increasing capacity of spillway and
allied structures as well as results of
same.

(2889) POTOMAC PROJECT.

(b) Stone and Webster Engineering Corporation.
(d) Experimental, for design.
(e) A distorted model with a vertical scale of
1/80 and a horizontal scale of 1/20 was
constructed of a section of the Potomac
River. The velocity distribution and heat
transfer characteristics of the river in
the area near the intake and outlet of the
power plant are being studied.
(f) Tests in progress.

(2890) NEW JERSEY ZINC COMPANY.

(b) Albright and Friel, Incorporated.
(d) Experimental; for design.
(e) A 1/250 horizontal scale and a 1/80 verti-
cal scale model of a section of the Dela-
ware River was constructed to study the
flow pattern in the area of the New Jersey
Zinc plant.
(f) Tests in progress.

(2891) PENNSYLVANIA RAILROAD COMPANY.

(b) Pennsylvania Railroad Company.
(d) Experimental; for design.
(e) A 1/200 horizontal scale and a 1/60 verti-
cal scale model of a section of the Dela-
ware River was constructed. The flow pat-
tern in the river near the Pennsylvania
Railroad pier is being studied.
(f) Tests in progress.

(2892) 16 INCH SWING CHECK VALVE.

(b) Knolls Atomic Power Laboratory.
(d) Experimental; for design.
(e) Flow data on the valve in various orienta-
tions obtained.

(f) Completed.

(2893) 16 INCH SWING CHECK VALVE.

(b) Walworth Company.
(d) Experimental; for design.
(e) Flow data on the valve in various orienta-
tions obtained.
(f) Completed.

(2894) 16 INCH SWING CHECK VALVE.

(b) Atwood and Morrill Company.
(d) Experimental; for design.
(e) Flow data on the valve in various orienta-
tions was obtained.
(f) Completed.

(2895) GUADALUPE DEVELOPMENT.

(b) Gannett Fleming Corddry and Carpenter, Inc.
(d) Experimental; for design.
(e) A 1/35 model including a section of the
Guadalupe River, a lucite intake and a
section of lucite tunnel was constructed
in order to study the velocity distribu-
tion in the intake and operating charac-
teristics of the tunnel and intake under
various flows and heads.
(f) Completed.

(2896) PEIXOTO DEVELOPMENT.

(b) Ebasco International.
(d) Experimental; for design.
(e) A 1/40 scale model of a section of the
spillway and river bed downstream was
built to study the operating character-
istics of the spillway and the erosion
pattern in the river bed.
(f) Completed.

(2897) ELRAMA POWER PLANT.

(b) Stone and Webster Engineering Corporation.
(d) Experimental; for design.
(e) A distorted model with a vertical scale
of 1/90 and a horizontal scale of 1/30
was constructed of a section of the
Monongahela River upstream and downstream
of the power plant. Velocity distribution
in the area of the intake and outlet as
well as heat transfer characteristics of
the river are to be determined.
(f) Tests in progress.

U. S. DEPARTMENT OF AGRICULTURE, AGRICULTURAL
RESEARCH SERVICE, Soil and Water Conservation
Research Division.

EASTERN SOIL AND WATER MANAGEMENT RESEARCH BRANCH.

Runoff and Erosion Control Section.

(1966) IMPROVED SYSTEMS FOR CONTROL OF RUNOFF AND
EROSION.

(b) Cooperative with the following state
Agricultural Experiment Stations and other
agencies for use throughout the 31 Eastern
States: Georgia, Illinois, Indiana, Iowa,
Maryland, Mississippi, Miisouri, New Hamp-
shire, New York, South Carolina, Wisconsin.
Some studies under this project are re-
ported in more detail as cooperative re-
search under the respective states.

(c) Dr. L. B. Nelson, Eastern Soil and Water
Management Research Branch, Plant Industry
Station, Beltsville, Maryland.

(d) Experimental and field investigations,
applied research for development and design.

(e) The purpose of these studies is to obtain
fundamental information on the mechanics of
rainfall runoff and erosion, to determine
the effects of the basic factors - climatic,
topographic, soil and cover on runoff and
soil loss, and to evaluate various soil and
water management practices from the stand-
point of runoff and erosion control in the
humid region. Supporting erosion control
practices including terracing and strip
cropping are developed and improved to
function effectively in the present day
multiple-row-power system of farming. The
relationships and evaluations secured from
the studies are combined into equations or
graphs for estimating runoff and individual
field soil loss for use in the design of
conservation farm plans and in determining
probable sediment production for use in
watershed protection programs. Grass
waterways are studied from the standpoint
of establishment and maintenance and their
use coordinated with grade stabilization
structures and supporting erosion control
practices. Methods for the establishment
and maintenance of vegatation for erosion
control on areas of exposed subsoil, in-
cluding roadside areas are under develop-
ment. The integration of soil and water
management, supporting erosion control
practices and waterways are studied on
individual fields and in farm-sized units
to determine and improve their practicabi-
lity for farm use. Improved techniques
and devices are developed to facilitate the
making of required research measurements.
The work is carried on in carefully con-
trolled laboratory and fractional acre
plot studies and on primary unit or field
sized watersheds in different cover or
management practices. Both meteorological
and hydrological measurements are made. A
field plot size rain simulator is under
development to hasten evaluation of prac-
tices. The basic data are assembled in a
central statistical laboratory for place-
ment on punch cards for machine and graphi-
cal correlation analysis.

(g) A rainfall parameter has been identified
that accounts for a high percentage of
individual storm erosion from fallow plots.
It is rainstorm energy times maximum 30
minute intensity. This will enable the es-
tablishment of erosion potentials for dif-
ferent climatic areas and increase the ac-
curacy of the erosion equation by inclusion
of an efficient rainfall factor.

(h) "A Brief Summary of Runoff and Erosion
Studies at Watkinsville, Ga.", A. P.
Barnett, Agr. Engin. (in press).
"A Second Look at Brighton", C. S. Britt
and C. S. Slater, USDA Soil Conserv.
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"Soil and Water Conservation Research",
C. S. Britt and C. S. Slater, Univ. of
Maryland 69th and 70th Annual Reports.
"Costly Erosion Can be Controlled", J. R.
Carreker, Cotton Trade Jour.-August 1956
Cotton Mechanization and Insect Control
Supplement, 36 (34):1-16 (1956).
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duction", J. R. Carreker, Cotton Trade
Jour. (in press).
"Making Terraces Parallel", J. R. Carreker,
Prog. Farmer (in press).
"Effects of Good Management Following Soil
Erosion", G. R. Free, Soil Sci. Soc. Amer.
Proc. (in press).
"Soil Erosion on Long Island-Its Control",
G. R. Free, C. S. Winkelblech, and H. M.
Wilson, Cornell Extension Bul. No. 968
(1956.) Revision.
"Keep the Soil in its Place", G. R. Free,
Rural New York, 107:359-360 (1957).
"Control of Runoff and Erosion on Almena
Silt Loam in Wisconsin", O. E. Hays and
A. J. Attoe, ARS 41-16 (1957).
"Factors Affecting Sheet and Rill Erosion",
D. D. Smith and W. H. Wischmeier, Trans.
AGU (in press).
"Terrace Maintenance", D. D. Smith, Hoard's
Dairyman, 102(10):534-535 (1957).
"Factors Affecting Rainfall Erosion and
Their Evaluation", D. D. Smith, Report
Commission of Continental Erosion, IASH,
IUGG (in press).
"Progress in Erosion Control Over the Last
Fifty Years", M. L. Nichols and D. D. Smith,
Agri. Engin. 38(6):422-425 (1957).
"Rainfall Energy and its Relationship to
Soil Loss", W. H. Wischmeier and D. D. Smith,
Trans. AGU (in press).
"Erosion Control Practices for the Fayette
Soil Area", O. E. Hays and R. E. Taylor,
USDA Agr. Inf. Bul. (in press).
"Evaluation of Factors in the Soil Loss
Equation", W. H. Wischmeier, D. D. Smith,
and R. E. Uhland, Agr. Engin. (in press).

Irrigation and Drainage Section.

(2898) IRRIGATION AND DRAINAGE PRACTICES AND
REQUIREMENTS.

(b) Cooperative with the following state

Agricultural Experiment Stations and other agencies for use throughout the 31 Eastern States: Alabama, Georgia, Illinois, Louisiana, Maine, Maryland, Minnesota, Miss., Missouri, New Jersey, North Carolina, Pennsylvania, Puerto Rico, South Carolina, Virginia, Wisconsin. Some of the studies under this project are reported in more detail as cooperative research under the respective states.

(c) Dr. L. B. Nelson, Eastern Soil and Water Management Research Branch, Plant Industry Station, Beltsville, Maryland.

(d) Experimental and field investigations including both basic and applied research for development purposes.

(e) The purpose of these studies is to obtain information on soil-plant-water relationships as they influence irrigation and drainage requirements of crops which are adapted to farm conditions in the humid regions. Investigations range from carefully controlled studies on soil-plant-water relationships to irrigation and drainage field trials. Under controlled environment conditions the effects of the physical state of soil moisture on water uptake and on ion uptake by plants is investigated. Under similar conditions the rate of removal of excess moisture which is required to maintain adequate aeration is evaluated at different temperatures and at different stages of plant development. The quantities of water necessary to meet requirements of major crops at various stages of growth are determined. Evapotranspiration under different climatic conditions is measured, which, along with soil moisture retention characteristics and rooting depths, forms a basis for the survey of frequencies and intensities of moisture deficiencies and excesses that is in progress. The effects of brackish water on plants and soil is evaluated along the Eastern Seaboard where hurricanes and other weather disturbances may subject soil and plants to saline water from the ocean.

(g) Data were obtained and evaluated during the past year on the water requirements of corn, peanuts, cotton, tobacco, soybeans and several forage crops.

(h) "Make Full Use of Stored Soil Moisture", V. C. Jamison, Jour. of Soil and Water Conserv. 12:122-125 (1957).
"Influence of Soil Moisture Levels and Seasonal Weather on Efficiency of Water Use by Corn", D. B. Peters and J. Letey, Agron. Jour. 49:362-365 (1957) illus.
"Water Uptake Under Systems of Moisture Content and Moisture Tension", D. B. Peters, Soil Sci. Soc. Amer. Proc. (in press).
"Field Evaluation of Evapotranspiration", (abstract) W. A. Raney, Agr. Engin. (in press).
"Soil Physical Characteristics in Relation to Soil Groupings", W. A. Raney and R. R. Bruce, Soil Sci. Soc. Amer. Proc. (in press).
"Soil Moisture Evaluation", W. A. Raney

and M. D. Thorne, ARS 41-6 (May 1956).
"Evaluation of Evapotranspiration in Field Plots", W. A. Raney, Agr. Engin. (in press).
"Neutron and Gamma Radiation as Applied to Measuring Certain Physical Properties of Soil in its Natural State", C. H. M. van Bavel and N. Underwood, Proc. 6th Int. Cong. Soil Sci. B:355-360 (1956).
"A Simplified Procedure for Sampling Soil Moisture", H. A. Weaver, Agr. Engin. 37(10):676 (1956).
"Water in Agriculture", J. R. Carreker, Academy of Sci. Bul. (in press).
"Evapotranspiration Rates for Alfalfa and Vegetable Crops in New York State", N. H. Peck, M. T. Vittum, and R. D. Miller, Soil Sci. Soc. Amer. Proc. (in press).
"Place of Irrigation in Grassland Agriculture", W. A. Raney, Agr. Engin. (in press).
"Cylinder Infiltrometers for Determining Irrigation Application Rates", C. S. Slater, Soil Sci. Soc. Amer. Proc. 21:457-460 (1957), illus.
"Irrigator for Research Plots", G. N. Sparrow, R. L. Carter and J. R. Stansell, Agr. Engin. (in press).
"Cotton Irrigation in Southeast", J. F. Thornton, Cotton Gin-Oil Mill Press 58(1):22, 23 (1957) illus.
"Estimating Soil Moisture Conditions and Time for Irrigation with Evapotranspiration Method", C. H. M. van Bavel, ARS 41-11:16 pp. (1956).
"Practical Use of Knowledge about Evapotranspiration", C. H. M. van Bavel, Agr. Engin. (in press).
"A Regional Approach to the Analysis of Drought Incidence", C. H. M. van Bavel, Proc. 6th Int. Cong. Soil Sci. D:653-660 (1956).
"Can We Predict Drought?", C. H. M. van Bavel, Better Farming Methods, 29(4):20-22 (1957) illus.
"Agricultural Drought in Virginia", C. H. M. van Bavel and J. H. Lillard, Tech. Bul. 128, Va. Agr. Expt. Sta. 38, (1957) illus.

(2899) IRRIGATION AND DRAINAGE FACILITIES.

(b) Cooperative with the following state Agricultural Experiment Stations and other agencies for use throughout the 31 Eastern States: Alabama, Georgia, Louisiana, Minnesota, Missouri, New York, North Carolina, Virginia, Vermont, Illinois, Ohio, Wisconsin. Some of the studies under this project are reported in more detail as cooperative research under the respective states.

(c) Dr. L. B. Nelson, Eastern Soil and Water Management Research Branch, Plant Industry Station, Beltsville, Maryland.

(d) Experimental and field investigations and applied research for design purposes.

(e) The purpose of these investigations is to develop irrigation and drainage facilities for adequate control of water on to and off of farm land in a manner that will allow maximum conservation of soil and water resources. The various steps

required in land conditioning and forming for efficient use of soil and water resources are investigated as a segment of water control research. Factors which modify or control the development and storage of water resources on the farm are investigated. Tile, mole, and surface drainage systems of varying designs and materials are investigated with respect to their efficiencies in controlling rates of removal of excess water. Studies are conducted to determine soil, crop, and cultural practices that will improve internal drainage of the soil profile, and that will insure long-time functioning of the drainage installations. Studies are made of improved engineering designs and techniques for maintaining controlled water table levels under both organic and mineral soils. Attention is given to development of more rapid drainage research techniques.

(g) Data were obtained during the past year on the effectiveness of various systems for managing water in the course of irrigation as well as during removal of excess water. Additional data were obtained on the hydraulics of tile junctions.

(h) "Hydraulic Characteristics of the Junctions of Equal-Sized Drainage Tile", F. W. Blaisdell and P. W. Manson, Proc. 6th Int. Cong. Soil Sci. (Watershed Technology). "Drainage Problems and Methods", T. W. Edminster and R. C. Reeve, U. S. Dept. Agr. Yearbook of Agriculture, 1957, Soil:378-385 (1957). "Drainage in the Lower Southeastern Coastal Plain", R. L. Green, E. A. Schlaudt, and S. Krock, Agr. Engin. (in press). "Energy Losses at Drain Tile Junctions", P. W. Manson and F. W. Blaisdell, Agr. Engin. 37(4):249-252 (1956). "Land Forming for Drainage in Louisiana", I. L. Saveson, Assoc. South. Agr. Workers Proc. 54th Ann. Conv. 50-51 (1957). "Flat Planting of Sugarcane on Graded Land", I. L. Saveson ARS 41-12:10pp (1956).

Soil-Plant Relationships Section.

(26) DRAINAGE INVESTIGATIONS IN COACHELLA VALLEY, CALIFORNIA.

See University of California, College of Agriculture, Division of Irrigation and Soils, page 6.

(1194) PRINCIPLES UNDERLYING THE MOVEMENT OF AIR AND WATER INTO AND THROUGH SOILS.

(b) Laboratory project.
(c) Mr. R. C. Reeve, U. S. Salinity Laboratory, P. O. Box 672, Riverside, California.
(d) Experimental; basic research.
(e) To investigate the factors that influence the flow of water and air into and through soils.

(2172) NOVEMENT AND DISTRIBUTION OF WATER AND SALTS IN UNSATURATED SOIL.

(b) Laboratory project.
(c) Dr. L. A. Richards, P. O. Box 672, Riverside, California.
(d) Field investigation; basic research.
(h) "Soil Moisture", L. A. Richards and S. J. Richards, Yearbook of Agriculture (USDA) 1957, SOIL, p. 49-60. "Analysis of Soil Water-Content Changes Following the Irrigation of Alfalfa", Gen Ogata, L. A. Richards and W. R. Gardner, manuscript.

(2173) MOVEMENT OF WATER AND SALTS FROM A WATER TABLE.

(b) Laboratory project.
(c) Dr. W. R. Gardner, P. O. Box 672, Riverside, California.
(d) Theoretical and experimental; basic research.
(e) Equations describing evaporation from a water table have been formulated and solved. Data on evaporation from laboratory soil columns agree very well with theory.
(h) "Some Steady State Solutions of the Unsaturated Moisture Flow Equation with Application to Evaporation from a Water Table", W. R. Gardner, Soil Science, 1957 (in press). "Laboratory Studies of Evaporation from Soil Columns in the Presence of a Water Table", W. R. Gardner and Milton Fireman, Soil Science, 1957 (in press).

(2174) MATHEMATICAL THEORY FOR THE MOVEMENT OF SOLUBLE SALTS BY LEACHING.

(b) Laboratory project.
(c) Dr. W. R. Gardner, P. O. Box 672, Riverside, California.
(d) Theoretical and experimental; basic research.
(e) Purpose is to derive a mathematical theory for the leaching of soluble salts from soils. The soil properties which govern the amount of leaching are determined. Mathematical results are checked experimentally in laboratory soil columns.
(f) Completed.
(g) Good agreement between theory and laboratory and field plot results.
(h) "A Descriptive Theory of Leaching", W. R. Gardner and R. H. Brooks, Soil Science 83: 295-304, 1957.

(2648) EVALUATION OF THE LEACHING REQUIREMENT THEORY FOR CONTROLLING SOIL SALINITY.

(b) Laboratory project.
(c) Mr. R. C. Reeve, U. S. Salinity Laboratory, P. O. Box 672, Riverside, California.
(d) Experimental; basic research.
(e) Involves the measurement of both inflow and outflow of both water and salt from soil columns in lysimeters in which crops are grown under varying water table depths and irrigation regimes. To test the validity of the leaching requirement theory for controlling soil salinity and to

determine the effects of soil salinity and
water table conditions on the growth of
crops.

(2900) ENTRY OF WATER INTO SOILS.

  (b) Laboratory project.
  (c) Dr. W. R. Gardner, P. O Box 672, Riverside,
       California.
  (d) Theoretical and experimental; basic re-
       search.
  (e) The diffusion equation is applied to the
       movement of water into soil. The effect
       of water content and soil properties on in-
       take rates is determined. The influence of
       exchangeable sodium and salinity of irriga-
       tion water is also included.
  (h) "Solutions and Tests of the Diffusion
       Equation for the Movement of Water in Soil",
       W. R. Gardner and M. S. Mayhugh, Soil Sci.
       Soc. Amer. Proc. (in press).

WATERSHED TECHNOLOGY RESEARCH BRANCH.

  (150) EXPERIMENTAL WATERSHED STUDIES.

       See also Stanford University Project 1946,
       page 66.

  (b) Cooperative with State Agricultural Experi-
       ment Stations Soil Conservation Service,
       U. S. Weather Bureau, U. S. Geological
       Survey, U. S. Bureau of Reclamation, U. S.
       Bureau of Public Roads, Stanford University,
       University of Iowa, St. Anthony Falls Hy-
       draulic Laboratory, Central and Southern
       Florida Flood Control District, and the
       Wisconsin Valley Improvement Company.
  (c) Mr. Austin W. Zingg, Watershed Technology
       Research Branch, Plant Industry Station,
       Beltsville, Md.
  (d) Experimental; field and laboratory; for
       design of Watershed Protection and Flood
       Prevention Projects and general information
       in planning farms for soil and water con-
       servation.
  (e) Rainfall and runoff are measured on water-
       sheds ranging from 1 to 75,000 acres. In
       additon to rainfall and runoff measurements,
       studies are made on small Government-oper-
       ated areas of evapotranspiration, moisture
       storage, moisture transmission through the
       soil, hydrologic effect of physiography,
       tillage, and ground surface conditions,
       vegetal covers and soils and geology, and
       the effect of conservation farming on run-
       off and erosion, as well as the character-
       istics of flood runoff from agricultural
       watersheds. Hydrologic records of various
       kinds are being obtained on some 115 water-
       sheds at: Safford and Tombstone, Arizona;
       Ft. Lauderdale and Vero Beach, Florida;
       Watkinsville, Georgia; Iowa City, Iowa;
       College Park and Hagerstown, Maryland;
       East Lansing, Michigan; Oxford, Mississippi;
       McCredie, Missouri; Hastings, Nebraska;
       Newell, South Dakota; Albuquerque and Santa
       Rosa, New Mexico; Cohocton and Dutchess
       County, New York; Coshocton, Ohio; Still-
       water, Oklahoma; Riesel (Waco), Texas;

Blacksburg, Virginia; Colby, Fennimore and
LaCrosse, Wisconsin; Montpelier, Vermont.
Other studies include (1) analysis and
interpretation of accumulated records and
(2) development of procedures for general-
izing synthetic unit hydrographs for water-
sheds primarily under 3000 acres in size
and (3) unit established at Lincoln, Nebr.
cooperatively by U. S. Soil Conservation
Service, U. S. Bureau of Reclamation and
U. S. Agricultural Research Service to
develop methods for estimating the influ-
ence of watershed protection programs upon
water yields.
  (g) Amounts of runoff during selected time
       intervals from 1 hour to 7 days and peak
       rates are being compiled for 366 agricul-
       tural watersheds, ranging in size from less
       than 5 acres to 256 square miles, at 60
       locations in 27 states.
  (h) "Monthly Precipitation and Runoff for Small
       Agricultural Watersheds in the United
       States", USDA, ARS, Soil and Water Conser-
       vation Research Branch in cooperation with
       State Agr. Expt. Sta.
       "Subsidence of Organic Soils in the Florida
       Everglades", J. C. Stephens, Soil Sci. Soc.
       Amer. Proc. 20:77-80 (1956) illus.
       "Can We Save our Organic Soils", J. C.
       Stephens, USDA Soil Conser. 22:54-59, 72,
       (1956) illus.
       "Soil Moisture Measurements in Irrigating
       Sweet Corn", F. R. Driebelbis and R. E.
       Youker, Jour. Soil and Water Conser.
       11:215-218, 1956.
       "Contour Plowing in the USA", L. L.
       Harrold, World Plowing Organization Guide
       Book, pp. 59-61, 1956.
       "Minimum Water Yield from Small Agricul-
       tural Watersheds", L. L. Harrold, Amer.
       Geophys. Union Trans. 38:201-208 (1957)
       illus.
       "Average Monthly Percolation from the
       Coshocton Monalith Lysimeters, 1938-1955",
       F. R. Dreibelbis, Jour. Soil and Water
       Conser. 12:85-86, 1957.
       "A Short Method of Obtaining Mean Weight-
       Diameter Values of Aggregate Analyses of
       Soils", R. E. Youker and J. L. McGuinness,
       Soil Sci. 83:291-294, (1957) illus.
       "The Future of Arid Lands", G. F. White,
       Book Review by A. W. Zingg, Sci. Monthly
       84:267-268, 1957.
       "Soil Moisture Distribution on Irrigated
       Corn Plots", F. R. Dreibelbis and R. E.
       Youker, Soil Sci. Amer. Proc. 20:292-295,
       1956.
       "A Capacitance Meter for Estimating Forage
       Weight", J. E. Fletcher and M. E. Robinson,
       Jour. Range Mgt. 9:96-97, (1956) illus.
       "Research - The Basis of Sound Conservation
       Planning", L. L. Harrold, Land and Water 1
       (4):11-15, (1956) illus.

(1723) THE HYDRAULICS OF CONSERVATION STRUCTURES.

       See St. Anthony Falls Hydraulic Laboratory
       Projects Nos. 111, 1168, 1398, page 62;
       1929, 2386, page 63; and 2860, page 65.
  (b) Cooperative with the Oklahoma and Minnesota

Agricultural Experiment Station, the St. Anthony Falls Hydraulic Laboratory, and Colorado A and M College, Department of Civil Engineering, and Illinois State Water Survey, Urbana, Illinois.

(c) Mr. Austin W. Zingg, Watershed Technology Research Branch, Plant Industry Station, Beltsville, Maryland.

(d) Experimental; applied research for development and design.

(e) Research dealing with the design, construction, and testing of structures for controlling and conserving soil and water are carried out under this project. Field studies are made to determine the causes of deterioration of drainage ditches, terrace outlets, and hydraulic structures that have failed in service. Laboratory experiments in methods of preventing such deterioration are supplemented by field tests of those measures or devices that appear promising. Models of hydraulic structures are built and tested in the laboratory; and when the design has been developed to seemingly satisfactory operation, full-scale structures are tested before they are recommended for field use. At the Stillwater, Oklahoma Outdoor Hydraulic Laboratory tests are being made to establish friction coefficients of various crops for use in the Manning channel flow formula, and studies are being continued on the use of highway culverts for measuring flow rates. At the St. Anthony Falls Hydraulic Laboratory studies were continued on the capacity and performance of the hood inlet to the closed conduit spillway and on the hydraulic design characteristics of drain tile. Cooperative studies on drop inlets were initiated with the Illinois State Water Survey at Urbana, Ill. Tests under contract at Colorado A and M College to develop the optimum dimensions of cantilever outlets for circular discharge conduits from water retardation structures were concluded. A terminal report was received.

(g) Equations were defined for weir flow in the Hood Inlet:
For square edged,

$$Q/D^{5/2} = (1.83S^{1/15} + 0.60 \frac{h}{D}) \frac{a}{A} \qquad \frac{h}{D}$$

and for well rounded inlet

$$Q/D^{5/2} = (1.83S^{1/15} + 1.35\frac{h}{D}) \frac{a}{A} \qquad \frac{h}{D}$$

These equations are valid between $h/D = 0$ and $h/D = 0.8$.
The hood inlet study provided considerable data on the position of the hydraulic grade line at the conduit exit. The exit position of the hydraulic grade line varies with the discharge from well above the centerline at low flows to well below the centerline at high flows when the outlet discharges freely. Particularly in the case of large conduits and low total heads, the position of the hydraulic grade line

significantly and detrimentally affects the discharge. At Stillwater, Oklahoma tests on flow retardance properties of cotton and sudangrass provided basis for estimating "n" values for use in Manning's formula:

Cotton: N = 0.036 for 3" deep flows
N = 0.13 for 2 ft. deep flows

Broadcast Sudangrass:
N = 0.33 for 9" deep flows
N = 0.10 for 3 ft. deep flows

The contrary trends are due to differences in physical characteristics of the vegetation. Tests on Bermuda grass - Reed Canary grass channels showed no harmfull effects from three wet and dry cycles of five days of continuous low flow and fifteen days of no flow.
Model studies at Stillwater were used to calibrate a twin barrelled culvert in Virginia for runoff measurement and also for testing a rate measuring flume for measuring flashy sand laden flows in the Southwest.

(h) "Hydraulic Characteristics of the Junctions of Equal-Sized Drainage Tile", F. W. Blaisdell and P. W. Manson, Int. Cong. Soil Sci. Proc. 6th Cong. D:561-568, (1956) illus.
"Hydraulic Research", W. O. Ree, Soil Conser. 22:246-249, (1957) illus.
"Energy Losses at Draintile Junctions", P. W. Manson and F. W. Blaisdell. Agr. Eng. 37:249-252, 257, (1956) illus.
"Hydraulics of Closed Conduit Spillway", F. W. Blaisdell, Part I Theory and its Application. Tech. Paper No. 12 Series B and Part VIII Misc. Lab. Tests, Part IX Field Tests, Tech. Paper No. 19, Series B, University of Minnesota, St. Anthony Falls Hydr. Laboratory.
"Straight Drop Spillway", F. W. Blaisdell and A. F. Moretz, Agr. Eng. Handbook to be published by McGraw-Hill Co.
"The Box Inlet Drop Spillway and Its Outlet by F. W. Blaisdell and C. A. Donnelly", Discussion by N. E. Minshall, Trans., ASCE Vol. 121, pp 955-994, 1956.

(2175) SEDIMENTATION IN RESERVOIRS, STREAMS AND VALLEYS.

(b) Cooperative with State Agricultural Experiment Stations in Mississippi, Nebraska and New York, and with the Univ. of Mississippi.

(c) Mr. Austin W. Zingg, Watershed Technology Research Branch, Plant Industry Station, Beltsville, Md.

(d) Experimental; field and laboratory, for design of Watershed Protection and Flood Prevention Projects and general information in planning farms for soil and water conservation.

(e) Field and laboratory studies are made to determine sediment sources in watersheds, the character and amount of sediment carried out of watersheds, the nature and

rate of movement in channels, the nature and rate of streambank erosion, and the nature and rate of deposition of sediment in channels, on flood plains and in reservoirs and harbors. Field studies generally are confined to watersheds of less than 100 square miles in area. Evaluation studies are made of various types of control measures to determine their effectiveness in reducing sedimentation damages. The work is oriented to meet the immediate and specific needs for information for planning and design of watershed treatment programs in connection with soil conservation and flood prevention work. Studies are being carried on from field headquarters at Oxford, Miss.; Lincoln and Hastings, Neb.; and East Aurora, New York.

(g) In Mississippi a new technique was developed for studying the depth and pattern of momentary scour in sandbed streams. Log chains 20 to 40 feet long, anchored to stakes driven in the streambed, were laid on the streambed surface in the direction of flow. Subsequent measurements of the positions of these chains has revealed that substantial channel scour occurs with increased stages of flow but that the streambeds essentially resume their former level as the stages recede. It is anticipated that continued observations along these lines will provide qualitative and perhaps quantitative information on the role of bed changes in sediment transport.

In further study of the mechanics of sediment transport a major research contract was negotiated with the California Inst. of Technology for investigating some of the pertinent factors affecting sediment movement which cannot be isolated and evaluated under the flow conditions of natural stream channels. This research is basic in nature but closely coordinated with and supplemental to the studies on natural watersheds.

On a bend of Buffalo Creek, near East Aurora, New York it was found that an experimental revetment of newly developed cellular concrete blocks successfully withstood the high velocities and ice flow abrasion during a rather severe flood. The protection provided, when compared with adjacent reaches of stone revetment, was encouraging. The cellular blocks are also being used in an exploratory study of a method for determining the stream forces along the banks of streams. The depth of removal of material placed in the open cells of the blocks is believed to be a measure of the forces. Knowledge of the magnitude of these forces would help materially in the design of streambank protection works.

Research was continued on the relation of sediment yield rates to watershed characteristics. In this connection reservoir sedimentation surveys were made on 30-odd stock-water ponds in both the Alamogordo Creek watershed in New Mexico and in Walnut Gulch watershed in Arizona and on Mission Sabetha reservoirs in Kansas. Similar studies are

being initiated on the fifteen reservoirs instrumented in South Dakota for hydrologic investigations. At Hastings, Nebraska sediment measurements were initiated on a 481-acre mixed cover watershed farmed with prevailing practices and on a 411-acre conservation treated watershed. Studies of sediment production and delivery rates are a major aspect of the expanded studies in Mississippi as carried out on Pigeon Roost Creek watershed and on lands of the Holly Springs Branch of the Mississippi Agricultural Experiment Station.

At Lincoln, Nebraska available information was assembled, compiled and partially analyzed in studying the vertical and longitudinal distribution of sediment in more than 60 reservoirs. A study of the shapes of dams resulted in development of new formulas for more refined computation of reservoir sedimentation surveys. Cooperation was continued with the Inter-Agency Sedimentation Project at the St. Anthony Falls Hydraulic Laboratory to develop an instrument to automatically measure sediment concentration in stream flow. Architectural and engineering designs are now being made for a major sedimentation research laboratory to be constructed at Oxford, Mississippi during fiscal year 1959. It is proposed that this facility will be used for both basic and applied research on the mechanics of sediment movement and deposition and in conjunction with increased emphasis on evolution of improved means and measures for stream channel stabilization. Studies will be continued on factors affecting sediment production and delivery rates of watersheds in relation to causal factors. Investigations into the principles of reservoir silting, including studies of the density and distribution of sediment, will be continued and strengthened as facilities permit.

(h) "A Study of Relative Erodibility of a Group of Mississippi Gully Soils", R. Woodburn and J. Kozachyn, Amer. Geophys. Union Trans. Dec. 1956.
"Some Aspects of Streambank Protection", D. A. Parsons, approved for publication in Agr. Eng. Jour.

WESTERN SOIL AND WATER MANAGEMENT RESEARCH BRANCH.

(151) LINING OF IRRIGATION CANALS AND RESERVOIRS.

(b) Laboratory project; Agricultural Research Service, Utah State University, and Bureau of Reclamation cooperating.

(c) Dr. C. W. Lauritzen, Agricultural Research Service, Box 177, College Hill, Logan, Utah.

(d) Experimental; basic and applied research.

(e) Linings for irrigation canals and reservoirs are being tested to develop more effective and lower cost methods of reducing seepage losses in irrigation systems. The investigation includes: (1) Evaluation of physical properties of

lining materials; (2) model testing of linings in an outdoor laboratory; and (3) field testing at selected sites to determine relative durability under varying subgrade and climatic conditions.

(g) A built-up asphalt lining, consisting of alternate layers of sprayed asphalt and treated jute burlap, has shown good durability as an exposed lining. Installation costs vary with site conditions but have been lower than costs for concrete or prefabricated asphalt linings. Installations have been made at a number of locations to test durability under widely varying climatic conditions. Additional installations to extend the range of test site conditions are planned.

(h) "Canal and Reservoir Lining Materials", C. W. Lauritzen, Proceedings New Mexico Water Conference, November 1956 (in press). "Seepage Control with Plastic Film", C. W. Lauritzen, Irrigation Engineering and Maintenance Magazine, March 1957. "Canal and Reservoir Lining Materials", C. W. Lauritzen, Proceedings Third Congress, International Commission on Irrigation and Drainage, Reports for Discussion, Ques. 7, R. 16, May 1957.

(820) THE STUDY OF SEEPAGE LOSSES FROM IRRIGATION CHANNELS.

(f) Suspended.
(h) "Measurement of Canal Seepage", A. R. Robinson and Carl Rohwer, American Society of Civil Engineers, Separate No. 728, 1956.

(2177) WATER REQUIREMENTS IN THE IRRIGATED AREAS OF THE PACIFIC SOUTHEAST.

(b) Laboratory project, cooperative with Western States' Agricultural Colleges, State Engineers, Soil Conservation Service, and Bureau of Reclamation.
(c) Mr. Harry F. Blaney, 1509 Post Office and Court House Building, Los Angeles, Calif.
(d) Field experiments and office analysis.
(e) (1) To determine the consumptive use of water by agricultural crops and native vegetation and water requirements for irrigated crops. (2) To compile and prepare for publication available data relating to irrigation requirements and consumptive use as determined by field experiments. (3) To estimate water requirements from climatological and other data.
(g) Normal rates of consumptive use and irrigation water requirements have been estimated and provisional reports prepared for several western states and Colorado River Basin. These values have been computed by the Blaney-Criddle formula: U = KF. Where U is a consumptive use in inches, K is an empirical coefficient based on experimental measurements and F is a factor determined from monthly mean temperatures and percent day-time hours. "Consumptive Use of Ground Water by Phreatophytes and Hydrophytes", Harry F. Blaney, Proceedings Tenth General Assembly of the

International Union of Geodesy and Geophysics, Rome, Italy, September 1954. "Evapo-Transpiration Measurements in Western United States", Harry F. Blancy, Proceedings Tenth General Assembly of the International Union of Geodesy and Geophysics, Rome, Italy, September 1954. "Evaporation and Evapo-Transpiration Studies by the U. S. Department of Agriculture in the Pacific Southwest", Harry F. Blaney, Publication No. 40, Association Internationale d'Hydrologie (de l' U.G.G. F.), Dejon, France, 1956. "Research on Evaporation and Evapo-Transpiration in the United States", R. K. Linsley, H. F. Blaney, G. E. Harbeck, M. A. Kohler, Publication No. 40, Association Internationale d'Hydrologie (de l' U.G.G.F.) Dejon, France, 1956.

(2179) EVAPORATION AND CONSUMPTIVE USE OF WATER INVESTIGATIONS IN THE SAN FRANCISCO BAY AND ADJACENT AREA.

(b) Laboratory project, cooperative with Div. of Water Resources, State of California; and the Corps of Engineers, San Francisco Bay District, U. S. Army.
(c) Mr. Dean C. Muckel, P. O. Box 180, Berkeley, Calif.
(d) Field investigation.
(e) To determine rates of evaporation from fresh water surfaces, the consumptive use of fresh water by marshland vegetation (tules and cattails), and the consumptive use of water by salt grass at varying depths to water table in the San Francisco Bay and adjacent areas.
(h) "Second Progress Report on Evaporation Investigations in the San Francisco Bay Region, California", Dean C. Muckel, Mimeographed report to the Corps of Engineers, U. S. Army, Nov. 1956.

(2180) EVAPORATION LOSSES FROM RESERVOIRS.

(b) Laboratory project, cooperative with the State of California and County Flood Control Districts.
(c) Mr. Harry F. Blaney, 1509 Post Office and Court House Bldg., Los Angeles, Calif.
(d) Field investigation.
(e) To determine evaporation losses from reservoirs and lakes in California and compile and prepare for publication reliable evaporation and related data measured since 1945 in cooperation with the State Engineer of California. Field measurements are being made in cooperation with the State and local agencies on fifteen stations ranging in elevation from -240 feet below sea level at Salton Sea to 9,194 feet at Kaiser Pass in the Sierra-Nevada mountains.
(g) Monthly evaporation from pans, temperature, humidity, wind movement, and precipitation are being compiled for the various stations. Evaporation from Lakes' surface is being computed by reduction factors. In the

mountain areas, records are being kept at Shaver Lake (elevation 5,376 feet); Huntington Lake (elevation 6,954 feet); Florence Lake (elevation 7,345 feet); Kaiser Pass (elevation 9,194 feet).

(h) "Evaporation from Free Water Surfaces at High Altitudes", Harry F. Blaney, Paper 1104, Journal of Irrigation and Drainage, American Society of Civil Engineers, Nov. 1956.
"Evaporation Study at Silver Lake in the Mojave Desert, California", Harry F. Blaney, Trans. Am. Geophys. Union, Vol. 38:2, April 1957.

(2181) STORAGE OF WATER UNDERGROUND FOR IRRIGATION IN CALIFORNIA.

(b) Laboratory project.
(c) Mr. Leonard Schiff, P. O. Box 513, Bakersfield, California.
(d) Experimental applied research.
(e) To determine the factors affecting the percolation rate on water-spreading areas, and to devise ways and means to increase the percolation rate. In some soils the percolation rate decreases during spreading, and the objectives are to determine the cause of the decrease and to find practical methods of maintaining the high initial rates. Field tests are being made on test ponds and strips.

(2184) DRAINAGE OF IRRIGATED LAND IN THE UPPER COLORADO RIVER BASIN.

(b) Laboratory project, cooperative with Colorado Agricultural Experiment Station and the Soil Conservation Service.
(c) Mr. M. M. Hastings, P. O. Box 786, Grand Junction, Colorado.
(d) Experimental and field investigation; applied research.
(e) (1) To develop procedures for making drainage investigations involving the source, amount and distribution of excess water, and (2) to evaluate the effects of water logging on soil permeability and crop response.

(2185) SPRINKLING AS A METHOD OF APPLYING WATER TO IRRIGATED FARM LANDS, ITS PROBLEMS AND LIMITATIONS.

(b) Laboratory project.
(c) Mr. Claude H. Pair, P. O. Box 835, Boise, Idaho.
(d) Experimental; applied research.
(e) The objectives of this study are: (1) To obtain more precise information for the design, layout, installation and operation of sprinkler irrigation systems on various soil types, slopes and crops under various weather conditions; (2) to determine the effect of sprinkling upon various soils and crops; (3) to determine the economic limitations in the use of sprinkler irrigation systems; and (4) to assist in the development and testing of better sprinkler equipment and more efficient operating

procedures. Work is continuing on items (1) and (2) of (e) along with testing pressure regulating valves for use in sprinkler systems.

(2279) LABORATORY AND FIELD STUDY ON THE VORTEX TUBE SAND TRAP.

(b) Laboratory project, cooperative with Colorado State University.
(c) Mr. A. R. Robinson, Colorado State Univ., Fort Collins, Colorado.
(d) Experimental; applied research; field evaluations; for design.
(e) Tests have been completed on full scale vortex tubes using laboratory facilities. Efficiencies of trapping sediment under various conditions are being computed. Tubes of different shapes and sizes were tested. Field evaluations of existing sand trap installations are being planned.
(g) Tubes of different shapes seem to operate equally well. The critical points of design seem to be the size and length of tube. The efficiency of trapping varies with the velocity of flow and the size of material being moved.

(2649) DEVELOPMENT OF DRAINAGE DESIGN CRITERIA FOR IRRIGATED LANDS.

(b) Laboratory project, cooperative with Colorado State University.
(c) Mr. A. R. Robinson, Agricultural Research Service, Colorado State University, Fort Collins, Colorado. Mr. N. A. Evans, Colorado Agricultural Experiment Station, Colorado State University, Fort Collins, Colorado.
(d) Experimental; applied research for field design.
(e) Both field and laboratory studies are being made to determine the relationship of discharge, farm water supply, physical features of the drain systems, and drainage characteristics of the soil. Another objective is to check the theoretically derived relationships between soil drainage properties and the shape of the water table after drainage. Work is underway to determine if a detailed knowledge of the geometry and hydraulic conductivities of the soil system in a small area can be extrapolated to a large area to enable the rational design to be made. This study makes use of electric analog technique.

(2650) EFFECT OF WATER TABLE DEPTH ON IRRIGATION REQUIREMENTS AND YIELD OF LAHONTAN ALFALFA.

(b) Laboratory project, cooperative with Nev. Agricultural Experiment Station.
(c) Mr. Victor I. Myers, Nevada Agricultural Experiment Station, Reno, Nevada.
(d) Experimental; applied research.
(e) The water use and growth of alfalfa as related to varying water table depths, soil texture and irrigation regimes are being evaluated in field lysimeters.

(2651) DRAINAGE INVESTIGATIONS IN THE NORTH SHORE
AREA OF CARSON LAKE, NEVADA.

(b) Laboratory project, cooperative with Nevada
Agricultural Experiment Station, Soil Con-
servation Service and Truckee-Carson Irri-
gation District.
(c) Mr. Victor I. Myers, Nevada Agricultural
Experiment Station, Reno, Nevada.
(d) Field investigation; applied research.
(e) Drainage investigations are being conducted
in an irrigated area north of Carson Lake
to determine the causes for drainage prob-
lems in the study area and to develop im-
proved equipment and procedures for con-
ducting investigations and methods for
alleviating drainage problems.
(f) Active.

(2652) UTILIZATION OF AVAILABLE WATER SUPPLIES IN
THE COLORADO RIVER BASIN OF NEVADA.

(b) Laboratory project, cooperative with Nevada
Agricultural Experiment Station and the
Soil Conservation Service.
(c) Mr. Victor I. Myers, Nevada Agricultural
Experiment Station, Reno, Nevada.
(e) A study to determine the present disposi-
tion of water in the Colorado River Basin
within Nevada and to evaluate the potential
water supply available for beneficial use
in this basin.

(2653) CONSUMPTIVE USE, WATER SUPPLY AND IRRIGA-
TION STUDIES IN SANTA BARBARA COUNTY,
CALIFORNIA.

(b) Laboratory project, cooperative with the
U.S.B.R., the U.S.G.S., and the Santa
Barbara County Water Users Assn.
(c) Mr. Paul Nixon, USDA Agricultural Research
Service, Lompoc, Calif.
(d) Basic and applied research.
(e) Objectives are: (1) To obtain basic data
on consumptive use of water by irrigated
crops and native vegetation; (2) to deter-
mine the contribution of rainfall and
return waters from irrigation to the
ground water supply; (3) to make irriga-
tion efficiency studies to improve irriga-
tion practices.

(2901) LABORATORY STUDY OF GRAVEL FILTER DESIGN
FOR IRRIGATION WELLS.

(b) Laboratory project; cooperative with the
Colorado State University.
(c) Mr. E. G. Kruse, Agricultural Research
Service, Colorado State University, Fort
Collins, Colorado.
(d) Experimental; applied research.
(e) Laboratory studies are being conducted to:
(1) Determine the relationship of pack-
aquifer ratio and the pack and aquifer uni-
formity for stable conditions, and (2)
develop generalized criteria for the selec-
tion and placement of gravel pack materials.

(2902) DEVELOPMENT AND IMPROVEMENT OF WATER
MEASURING DEVICES.

(b) Laboratory project; cooperative with the
Colorado State University.
(c) Mr. A. R. Robinson, Agricultural Research
Service, Colorado State University, Fort
Collins, Colorado.
(d) Experimental; applied research.
(e) This project includes laboratory and field
studies relative to evaluation and improve-
ment of existing water measuring devices
and to develop new measuring devices, pri-
marily for irrigation purposes. Work on
small Parshall flumes has been completed.
Development and calibration of trapezoidal
flumes is being initiated.
(g) Small measuring flumes of the Parshall type
were designed and calibrated.
(h) "Parshall Measuring Flumes of Small Sizes",
A. R. Robinson, Colorado Agricultural
Experiment Station, Tech. Bul. 61, October
1957.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE,
Alaska Forest Research Center.

(2654) EFFECT OF LOGGING ON PHYSICAL CHARACTER-
ISTICS OF SALMON STREAMS IN SOUTHEAST
ALASKA.

(b) Laboratory project.
(c) Mr. R. F. Taylor, Forester in Charge,
Alaska Forest Research Center, Box 740,
Juneau, Alaska.
(d) Field investigation; applied research.
(e) In developing the timber resources of the
region, it is essential that adequate
steps be taken to safeguard the important
fisheries resource. The objective is to
determine whether logging, carried out in
accordance with provisions required by the
Forest Service to protect salmon spawning
streams, causes physical changes to the
watershed and stream regimen which might
be harmful to the stream for salmon protec-
tion. The following factors are being in-
vestigated: (a) Changes in the stream
regimen; (b) erosion and sedimentation;
(c) stream channel change; (d) accumula-
tion of debris in streams; (e) change in
stream bottom material; and (f) water
temperature.
(g) The first, or calibration, phase of this
study has resulted in information on the
hydrological characteristics and other
factors, such as water temperatures, accu-
mulation of debris, stream bottom changes
of undisturbed streams in a glaciated
region with heavy precipitation.
(h) "Watershed Management and Research on
Salmon Streams of Southeast Alaska",
Harold E. Andersen and George A. James,
Journal of Forestry 55(1):14-17, 1957.
"The Effect of Logging on Discharge,
Temperature, and Sedimentation of a Salmon
Stream", George A. James, Alaska Forest
Research Center Technical Note No. 39,
2 pp., 1957.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE,
California Forest and Range Experiment Station.

(261) WATERSHED MANAGEMENT RESEARCH, SOUTHERN
       CALIFORNIA.

   (b) Laboratory project.
   (c) Dr. R. Keith Arnold, Dir., California
        Forest and Range Experiment Station, P. O.
        Box 245, Berkeley 1, California.
   (d) Experimental; field investigations; basic
        and applied research.
   (e) Purposes are (1) to determine how water-
        sheds function: what happens to the pre-
        cipitation, and how water and soil movement
        are influenced by conditions of vegetation,
        soil, geology, and topography; and (2) to
        develop methods of watershed management,
        including treatment of areas denuded by
        fire, to insure maximum yield of usable
        water and satisfactory flood runoff and
        soil erosion control. Major work center
        is the San Dimas Experimental Forest situ-
        ated in the San Gabriel Mountains of south-
        ern California. Here rainfall, runoff,
        and erosion are measured on two major
        drainage areas, on 10 large and 7 small
        watersheds within these areas, and on 24
        experimental plots. Vegetation cover on
        the watersheds is mostly mature brush or
        chaparral, unburned for 36 years or more.
        However, in 1953 about one-third of one
        large watershed was burned-over by wildfire
        and in 1938 one-fourth of another large
        watershed, 3 small watersheds, and 9 plots
        were denuded by wildfire. Fifteen other
        plots are equipped to obtain detailed in-
        formation on the disposition of rainfall
        from annual ryegrass, native scrub oak-
        chaparral, and a 28-year-old Coulter pine
        plantation. Twenty-six large lysimeters
        furnish comparisons of water use and sur-
        face runoff control by five species of na-
        tive shrubs, one species of pine, and a
        bunch-grass association. Climatic data
        are obtained from several meteorological
        stations. Ways of improving the native
        vegetation cover to reduce soil movement
        on mountain slopes are being studied in the
        Los Angeles River watershed. Measurements
        to determine kinds, rates, and volumes of
        soil movement (soil, rock, and organic de-
        bris) are made on eight study sites repre-
        senting typical watershed soil and vege-
        tation conditions. After normal erosion
        rates have been established, the above
        sites will be used to evaluate effects of
        promoting cover improvement practices upon
        soil stability.
   (g) Some marked effects of different kinds of
        plants on water yield and loss were indi-
        cated by a long-term lysimeter study. The
        lysimeters have soil six feet deep and veg-
        etation cover of pine, chamise, grass,
        buckwheat or oak, with one lysimeter kept
        bare as a control. Results for the first
        four years indicate (1) water yield from
        bare soil was greater than from soil in
        which vegetation was growing, but the yield
        was entirely as surface runoff; (2) water

yield from grass was much less than the
yield from bare soil, but the grass in-
creased infiltration and, thus, reduced
surface runoff. Further, ground water
yield occurred even in this period of sub-
normal precipitation; (3) all of water
available to evaporation in the lysimeters
with other vegetation and lost during each
dry season, with no ground water yield re-
sulting. Studies were made of defoliation
at various times during the spring and
summer as a means of saving water in small
lysimeters with two feet deep soil. Re-
sults were: (1) Defoliation changed the
rate of evaporation use, but had little
effect upon total summer use. (2) Defoli-
ation decreased transpiration by as much
as 0.11 inches of water per day during the
period of high moisture availability and
(3) plants defoliated on May 1 and June 1
survived the summer drought with a few new
green leaves, while plants defoliated on
July 1 or August 1 appeared dead at the
end of summer. In plot studies, on soils
12 foot deep, the brush was killed with 2,
4, 5,-T early in 1957. Water losses
through evaporation and transpiration
during the 1957 growing season were less
than half the loss from full-foliaged brush
areas, 9.0 inches versus 19.7 inches.
Poisoning of brush from deep soil areas and
removal of trees in riparian areas of two
experimental water sheds are underway to
test effects of treatment on streamflow
and sedimentation.

   (h) "Uses of Soil-Vegetation Survey Informa-
        tion in Watershed Management", by P. B.
        Rowe and E. A. Colman, Soil Sci. Soc. Amer.
        Proc. 21(1):112-114, 1957.

(2415) WATERSHED MANAGEMENT RESEARCH, NORTHERN
        CALIFORNIA.

   (b) Laboratory project.
   (c) Dr. R. Keith Arnold, Dir., California
        Forest and Range Experiment Station, P. O.
        Box 245, Berkeley 1, California.
   (d) Experimental; field investigations; basic
        and applied research.
   (e) The aim is to develop a hydrologic base
        for land management decisions. The hydro-
        logic effects of wildfires, of attempts at
        conversion of brushlands to grass, and of
        logging and other land uses are to be evalu-
        ated. Present studies emphasize develop-
        ment of methods of management of high ele-
        vation snowpacks for maximum control and
        yield of water. Major work center is in
        Berkeley with studies being conducted
        throughout northern California in the head-
        waters of the Kings, American, Yuba, Truckee
        and Feather Rivers. At Teakettle Snow Lab-
        oratory in the Kings River Basin five small
        watersheds are under calibration for eval-
        uation of streamflow and sedimentation.
        In the Onion Creek Watersheds in the
        American River Basin four streams are being
        gaged and sediment measured. Castle Creek
        in the Yuba River Basin is being gaged,
        suspended sediment measured, and basic snow

physics studies are under way. Daily meteorological measurements are being taken at three stations and radiation and snow physics at the headquarters station. At Sagehen Creek in the Truckee River Basin sediment and streamflow and their effects on fishlife are being studied in cooperation with the Department of Zoology, Univ., of California. At Swain Mountain Experimental Forest in the Feather River Basin snow is being measured in forests to be cut in strips and blocks next year.

(g) Snow accumulation and melt at 31 snow courses as related to solar radiation, exposure, slope, azimuth, and forest cover. Snow accumulation and melt were found to be more closely related to the heat received by a slope than to any other single factor studied. Hot south slopes received three times the winter heat than cooler north slopes; consequently, south slopes had 22 inches less water at the time of maximum winter snowpack. Spring melt was nearly twice as fast on the hot slopes. Shade of trees acts principally in delaying snow melt. Spring melt rates tended to be greater in very sparsely stocked forests than in the open and, progressively, less in more densely stocked forests. Studies of wind speeds and directions during snowfall hours showed 88 percent of the winds were from the south and southwest. Average storm winds varied from 2 to 14 mph. Interstorm winds were about one-half of the speed and less dominantly from the south. The studies are being expanded by study of snow accumulation and melt at 55 snow courses selected to give a wide range in sizes of forest openings, forest densities, on various slopes and azimuths. Wind velocities and directions and snow physics will be studied at some of these sites. Summer evapo-transpiration losses are being studied at 75 different forest sites. Inventories of Sierra Nevada hydrologic and forest conditions are continuing.

(h) "Relating Sediment Yield to Watershed Variables", Henry W. Anderson, Amer. Geophys. Union Trans. 38(6).
"Operation Wet-Blanket Gets Underway", Henry W. Anderson, Amer. Geophys. Union Trans. 38(3):414 (Abstract).
"Snow on Forested Slopes", Henry W. Anderson and T. H. Pagenhart, Proc. Western Snow Conf., 1957.
"Forest-Cover Effects on Snowpack Accumulation and Melt", Henry W. Anderson and J. E. Church, Central Sierra Snow Laboratory, Amer. Geophys. Union Trans. 38(1):116 (Discussions).
"Wind Direction During Snowfall at Central Sierra Snow Laboratory", Arnold Court, Proc. Western Snow Conf. 1957.
"Watershed Management Considerations for Sanitation-Salvage Logging in Southern California", Walt Hopkins, CF and RES Forest Research Note No. 121, pp 1-4.
"Anti-Freezing Hoods for V-Notch Weirs", C. O. Johannesen, Jour. Forest. 55(8):590.
"Reconnaissance Methods of Measuring

Erosion", Clark H. Gleason, Jour. Soil and Water Conserv. 12(3):105-107.
"Suggestions for Revision of Terminology Dealing with Fire", Arthur W. Sampson and Clark H. Gleason, Jour. Forest. 55(3):219, also Jour. Range Managt. 10(3):i.
"New Meteorological and Snow Studies in the Central Sierra", Kenneth J. Walsh, Proc. Western Snow Conf. 1957.
"Snow Surveying from the Snow Surveyors' Side", Peter J. Wyckoff, Proc. Western Snow Conf. 1957.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Intermountain Forest and Range Experiment Station.

Inquiries concerning the following projects should be addressed to Mr. Reed W. Bailey, Director, Intermountain Forest and Range Experiment Station, Ogden, Utah.

(2903) STUDIES OF HYDROLOGIC PROCESSES ON FOREST, BRUSH, AND RELATED RANGELANDS IN CENTRAL AND NORTHERN UTAH AND SOUTHWESTERN IDAHO.

(b) Laboratory project.
(d) Experimental and field investigations; basic and applied research.
(e) Studies include the determination of variability and probability of amount, rate, duration, time of occurrence, and depth-area and depth-area-intensity relations of gross rainfall and snowfall; determination of forces and factors affecting water content, accumulation, movement, freezing, ripening, melting, and evaporation of snow; determination of forces, factors, and soil profile characteristics affecting the capacity of soil and rock mantles for absorption and storage of soil water and the extent to which storage functions can be altered by modifying the soil, vegetation, and associated soil organisms and animals; determination of forces and factors involved in water loss by evaporation and evapo-transpiration processes and the effects of altering vegetation and site conditions on these processes.
(g) Maintained records at four elevational zone stations and on three snow courses in central Utah; maintained records at 20 rainfall recording stations and three snow courses in northern Utah; five additional snow storage gages added to networks; commenced an analysis of snow and related climatic and soil moisture data in northern Idaho; initiated plot work in aspen and mountain brush sites to determine consumptive water requirements of different vegetation; completed installation of measuring equipment on subalpine-herbaceous range test areas.
(h) "Air Movement Under an Aspen Forest and on an Adjacent Opening", R. B. Marston. Journal of Forestry 54(7):468-469, 1956.

(2904) STUDIES OF EROSIONAL PROCESSES ON FOREST, BRUSH, AND RELATED RANGELANDS.

(b) Laboratory project.
(f) Inactive, pending development of program.

(2905) IMPROVED WATERSHED MEASUREMENTS AND EVALUATION TECHNIQUES FOR FOREST, BRUSH, AND RELATED RANGELANDS.

(b) Laboratory project.
(d) Experimental and field investigations; basic and applied research.
(e) These studies include the development of an improved, portable type-F infiltrometer of suitable accuracy and operability to meet the needs of the Watershed Management Research program, and the development of methods and procedures for predicting various characteristics of water yields and other aspects of water quality from ungaged drainage basins.
(g) Published report on the design, development, and operation of a portable type-F infiltrometer. Developed a multiple-linear regression equation for predicting annual runoff from western white pine forest lands in northern Idaho, in which annual runoff was found to equal the sum of 98 percent of winter precipitation, plus 72 percent of spring and fall precipitation, plus 14 percent of summer precipitation, plus 28 times the antecedent September runoff, minus a constant 23.6; all expressed in inches.
(h) "Intermountain Infiltrometer", Paul E. Packer, Intermountain Forest and Range Experiment Station Misc. Pub. No. 14, 41 pp., processed, illus., 1957.

(2906) METHODS OF CLASSIFYING AND INVENTORYING WATER RESOURCES, WATER USES, AND SOILS OF FOREST, BRUSH, AND RELATED RANGELANDS.

(b) Laboratory project.
(f) Inactive pending development of program.

(2907) METHODS OF PREVENTING WATERSHED DETERIORATION ON OPERATED FOREST, BRUSH, AND RELATED RANGELANDS IN IDAHO AND UTAH.

(b) Laboratory project.
(d) Experimental and field investigation; basic and applied research.
(e) Studies to develop, apply, and evaluate the hydrologic and soil stabilizing effects of modified or new logging and post-logging rehabilitation practices in preventing erosion of slopes and channels and minimizing flood and sediment discharges; and to develop guides for locating, constructing, and maintaining logging haul roads to prevent serious erosion or damaging runoff from granitic soils in southwest Idaho.
(g) The amount of soil bared by harvest cutting timber from 35 logging compartments in southern Idaho was found to increase with an increase in amount of timber cut. Cutting by single tree selection caused significantly greater increases in soil disturbance than did cutting by group selection. Results are being prepared for publication.

The distance sediment is carried from logging road fill slopes was found to be related to: (1) Number of obstructions below the road fill; (2) spacing between cross-ditches on roadbed; (3) road gradient and (4) road embankment slope length. Results of this study are being prepared for publications.

(2908) METHODS OF REHABILITATING FLOOD AND SEDIMENT SOURCE AREAS ON DAMAGED FOREST, BRUSH, AND RELATED RANGELANDS.

(b) Laboratory project.
(d) Experimental and field investigations; basic and applied research.
(e) Studies to develop and evaluate methods and techniques of controlling excessive surface runoff and sheet and rill erosion from seriously depleted or inadequately protected sloping forest, brush, and related rangelands; and to develop and evaluate methods of stabilizing eroding cut and fill slopes bared by construction or other disturbances to lessen sediment production and improve the regularity and quality of streamflow.
(g) Four years after plowing and seeding a depleted subalpine range in central Utah forage production had doubled, but storm runoff, infiltration capacity, or sediment production was unchanged. Further thickening of vegetation in future years is expected to show an improvement in these conditions. Data obtained from a flood source watershed now being treated show that infiltration rates increase and surface runoff and erosion decrease with increasing amounts of plant and litter cover. Continued yearlong streamflow records on 5 streams, and obtained spring, summer, and fall records on 8 additional streams on the Davis County Experimental Watershed. Began a study to determine effects of seeding and fertilizing on establishment of plant cover on contour trenched flood source areas near Morehead Mountain in southwestern Idaho. Obtained first-year records of seedling survival in plant cover establishment tests on four timber sale areas on national forests in southwestern Idaho and installed an additional test area on another timber sale road.
(h) "Effects of Plowing and Seeding on Some Forage Production and Hydrologic Characteristics of a Subalpine Range in Central Utah", Howard K. Orr, Intermountain Forest and Range Experiment Station Research Paper No. 47, 1957.

(2909) METHODS OF IMPROVING WATER YIELDS FROM FOREST, BRUSH, ALPINE, AND RELATED RANGELANDS.

(b) Laboratory project.
(d) Experimental and field investigations; basic and applied research.
(e) A study to develop and evaluate methods of converting vegetation types on well-drained slopes to increase amount or

improve timeliness of water yields to
streams and ground-water basins without ac-
celerating erosion, increasing flood and
sediment discharges or impairing water qual-
ity in norhtern Utah; to develop and evalu-
ate methods for artificially controlling
snow accumulation and behavior characteris-
tics to increase amount or improve timeli-
ness of water yields without accelerating
erosion, increasing flood and sediment dis-
charges, or impairing water quality on
aspen covered well-drained slopes.

(g) Continued calibration measurements of run-
off and determined areas of the two drain-
ages involved in the vegetation conversion
study. Converted stream-gaging devices,
provided sediment trap basins, and con-
tinued calibration of streamflow on the al-
pine snow control study area in central
Utah.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE,
Northeastern Forest Experiment Station.

Inquiries concerning the following projects should
be addressed to Dr. Ralph W. Marquis, Director
Northeastern Forest Experiment Station, 102 Motors
Avenue, Upper Darby, Pennsylvania.

(656) WATERSHED MANAGEMENT RESEARCH, DELAWARE-
LEHIGH-EXPERIMENTAL FOREST, PENNSYLVANIA.

(b) Laboratory project; in cooperation with
the Pennsylvania Department of Forests and
Waters and U. S. Geological Survey.
(d) Field investigation; basic and applied re-
search.
(e) A study was started in 1948 on the Delaware-
Lehigh Experimental Forest, Monroe County,
Pa., to determine the water economy for a
1,530-acre watershed covered with scrub
oak. Afterwards, the cover will be con-
verted by planting and fire protection to
a commercially valuable type, and the
effect on water relations will be measured.
Installations have been established to
evaluate all components of a water balance
equation for the watershed.
(g) The watershed was calibrated on the basis
of 6 years of daily climatic and stream-
flow records; 282 acres of root-raked area
were planted in 1955 and 1956.
(h) "Factors Influencing Streamflow From Two
Watersheds in Northeastern Pennsylvania",
by Howard W. Lull and Herbert C. Storey,
Jour. Forestry 55:198-200, 1957.
"Physical Properties of 134 Soils in Six
Northeastern States", by A. R. Eschner,
B. O. Jones, and R. C. Moyle, Northeastern
Forest Exp. Sta. Paper 89, 11 pp., illus.,
1957.
"A Program of Watershed-Management Research
on Forest Lands in the Upper Delaware and
Susquehanna River Basins", by Howard W.
Lull and Irvin C. Reigner, Northeastern
Forest Exp. Sta. Paper 92, 33 pp., illus.,
1957.

(966) WATERSHED MANAGEMENT RESEARCH, POCONO EX-
PERIMENTAL FOREST, PENNSYLVANIA.

(b) Laboratory project.
(d) Field investigation; basic and applied re-
search.
(e) Studies have been started on the Pocono
Experimental Forest, Wayne County, Pa., to
determine effects of forest management
practices and logging operations upon the
quantity and quality of water yielded by a
small watershed. Installations have been
established to measure precipitation,
streamflow and rainfall interception.

(1187) FROST STUDIES IN THE NORTHEASTERN UNITED
STATES.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To determine the effect of land use and
condition upon type and depth of frost for-
mation. Periodic observations of frost
type and depth, snow depth, and water con-
tent were made on 186 plots throughout the
Northeast during the winters 1950-51 and
1951-52.
(g) A report of results has been prepared for
publication.

(1188) WATERSHED MANAGEMENT RESEARCH, FERNOW EX-
PERIMENTAL FOREST, WEST VIRGINIA.

(b) Laboratory project.
(d) Field investigation; basic and applied re-
search.
(e) Studies were started in 1951 on the Fernow
Experimental Forest, Tucker County, W. Va.,
to determine the effect of different levels
of cutting practices and different logging
methods upon water quantity and quality.
Five watersheds were equipped with stream-
gaging stations and raingages. No logging
will be done on these watersheds during a
calibration period.
Measurements are being made on areas adja-
cent to the gaged watersheds to determine
erosion rates on logging roads as influ-
enced by length and steepness of grade and
various erosion control measures.
(g) Five watersheds were calibrated and treat-
ment was started on four of the watersheds.
Four additional experimental watersheds
were added: two forested and two in
abandoned pasture.
(h) "Water Yields From Small Forested Water-
sheds", by Sidney Weitzman and Kenneth G.
Reinhart, Jour. Soil and Water Conserv.
12:56-59, 1957.

(2419) WATERSHED MANAGEMENT RESEARCH, HUBBARD
BROOK EXPERIMENTAL FOREST, NEW HAMPSHIRE.

(b) Laboratory project.
(d) Field investigation; basic and applied re-
search.
(e) The objective is to determine the effect
of forest type, condition, and treatment
on quantity and quality of streamflow.

Studies are conducted in plots and experimental watersheds on the 7500-acre experimental forest in the White Mountains at West Thornton, New Hampshire.

(g) Three weirs have been constructed and climatic stations established.

(h) "The Role of Forest-Humus in Watershed Management in New England", by G. R. Trimble, Jr. and Howard W. Lull, Northeastern For. Exp. Sta. Paper 85, 34 pp., illus. "New Hampshire Guides for Logging Roads and Skid Trails", by George R. Trimble, Jr., K. E. Barraclough, Theodore F. Breon, and Leslie Sargent, Jr., Extension Folder 35, Univ. of N. H., 4 pp., illus., 1957. "How Far From a Stream Should a Logging Road be Located?",by George R. Trimble, Jr. and Richard S. Sartz, Jour. Forestry 55: 339-341, 1957. "Snow and Frost Measurements in a Watershed Management Research Program", by Richard S. Sartz, Northeastern Forest Exp. Sta. Paper 96, 9 pp., illus., 1957. "Influence of Land Use on Time of Soil Freezing and Thawing in the Northeast", by Richard S. Sartz, Jour. Forestry 55:716-718, 1957.

(2910) WATERSHED MANAGEMENT RESEARCH, LEADING RIDGE WATERSHED, PENNSYLVANIA.

(b) Laboratory project; in cooperation with the School of Forestry, Pennsylvania State Univ. and the Pennsylvania Department of Forests and Waters.

(d) Field investigation; basic and applied research.

(e) A cooperative study was started in 1957 to determine the effect of forest cover and treatment on quantity and quality of streamflow in the oak-hickory type in Pennsylvania, and to study various basic soil-water relationships as they affect watershed management.

(g) Three experimental watersheds have been selected. One weir has been constructed and a climatic station established.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Pacific Northwest Forest and Range Experiment Station.

Inquiries concerning Projects Nos. 969, 2187, 2911, and 2912, should be addressed to Mr. R. W. Cowlin, Director, Pacific Northwest Forest and Range Experiment Station, P. O. Box 4059, Portland 8, Oregon.

(969) EFFECT OF LOGGING, CLEAR CUTTING AND OTHER FOREST OPERATIONS ON STREAMFLOW.

(b) Laboratory project.

(d) Field investigation; applied research.

(e) H. J. Andrews Experimental Forest, McKenzie River drainage, west central Oregon. Streamflow from three small experimental watersheds in virgin Douglas-fir has been measured for five years by means of trapezoidal flume stream gages. These observa-

tions provide a pretreatment calibration which will be carried on for three years or more. Planned treatments will test effect of two systems of timber cutting on water yield and erosion.
In 1960 it is planned to construct roads in one of the three watersheds to supply information on sediment yields. Survey for these roads began in 1957.
Bull Run watershed in cooperation with City of Portland Water Bureau. Pretreatment calibration measurements now being taken on three small watersheds within the Bull Run watershed, source of Portland's water supply. Cover is virgin Douglas-fir. Streamflow is being measured by trapezoidal flumes. Results of this study will help determine the future management policy on the watershed.

(2187) EFFECT OF CATTLE GRAZING ON EROSION.

(b) Laboratory project.

(d) Field investigation, applied research.

(e) Starkey Experimental Forest and Range, northeast Oregon. Study to determine the effect of heavy, moderate and light grazing on erosion, sediment production and runoff. Sediment catchment basins have been constructed in small drainages, one in each of six pastures in which are tested three rates of grazing and two systems of management: deferred-rotation and season-long use. Major effect on erosion will be determined by volume of sediment accumulated in the basins. Study now in its fourth year.

(2911) INFLUENCE OF FOREST COVER ON INTERCEPTION OF PRECIPITATION.

(b) Laboratory project.

(d) Field investigation; applied research.

(e) Blue Mountains, northeast Oregon. A study of the effect of lodgepole pine timber cover on the interception of snow and rain was begun in October 1956. Net rainfall and snowfall were measured during fall and winter months on five plots and compared with gross precipitation received in an adjoining opening.
H. J. Andrews Experimental Forest. A study of interception in old-growth Douglas-fir was begun in the summer of 1957. Net precipitation is measured by moving rain gages located at six representative sites; measurements of gross precipitation are being made in adjoining cutover areas.

(g) Blue Mountains. During winter and spring of 1956-57, gages in the forested plots averaged 76 percent as much precipitation as that recorded in openings, indicating 24 percent of winter and early spring precipitation was lost by interception.

(h) "Snow Interception Accumulation, and Melt in Lodgepole Pine Forests in the Blue Mountains of Eastern Oregon", Norman H. Miner and James M. Trappe, Pacific Northwest Forest and Range Expt. Sta. Res. Note 153, 4 pp., illus., 1957 (Processed).

(2912) EFFECT OF LOGGING ON EROSION.

(b) Laboratory project.
(d) Field investigation, basic and applied research.
(e) Corvallis watershed, Oregon Coast Range. Soils from three cutover areas were analyzed to determine the effect of logging and slash burning on physical properties of soils. Cutover areas were classified according to surface conditions into undisturbed, disturbed-unburned, lightly burned and severely burned. These were compared with adjoining uncut-undisturbed surface conditions.
Wenatchee River drainage, central Washington. Soils derived from three major parent materials were sampled and are being analyzed to determine their basic physical and chemical characteristics. Parent materials are Swauk sandstone, basalt and granite.
(f) Corvallis watershed study terminated 1957. Wenatchee River drainage study active.
(g) Corvallis watershed. Study results indicated that physical properties of soils are affected significantly where slash burning has been severe. Physical properties of soil in undisturbed, disturbed-unburned and lightly burned patches of the cutover areas remain closely similar to those under adjacent uncut timber stands.
(h) "Some Effects of Logging and Slash Burning on Physical Soil Properties in the Corvallis Watershed", C. T. Dyrness, C. T. Youngberg, and Robert H. Ruth, Pacific Northwest Forest and Range Expt. Sta. Res. Paper 19, 15 pp., illus., 1957, (Processed).

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Rocky Mountain Forest and Range Experiment Station.

(376) WATERSHED MANAGEMENT RESEARCH, MANITOU EXPERIMENTAL FOREST.

(b) Laboratory project.
(c) Mr. Raymond Price, Dir. Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colo.
(d) Field investigations; applied research.
(e) Studies of the influence of grazing, timber cutting, and revegetation of depleted watershed lands upon water supplies, erosion and sedimentation, to solve problems in management of watershed lands of the Rocky Mountain Front Range such as: (1) Effect of grazing intensity on the water absorption of granitic soils; (2) runoff and erosion from natural storms on bunchgrass plots; (3) runoff and erosion from natural storms on young pine plots; (4) effect of type conversion on runoff and erosion from small watersheds; and (5) characteristics of runoff from cloudburst storms on a large watershed.
(g) The recording of rainfall, runoff, and erosion from plots and watersheds

representing different complexes of soil, vegetation, and treatment has been continued in conformance with the long-term nature of the study.
(h) Annual report, 1956, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.
"Infiltration as Affected by Vegetation, Soil, and Cattle Grazing in Colorado Ponderosa Pine Ranges", E. J. Dortignac and L. D. Love. Manuscript in preparation 1957.

(377) WATERSHED MANAGEMENT RESEARCH, FRASER HYDROLOGIC LABORATORY.

(b) Laboratory project.
(c) Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colorado.
(d) Field investigations; applied research.
(e) (1) To determine influence of lodgepole pine and spruce-fir forests and of the management of these forests on the yield of water. (2) To evaluate the alpine snowfields of the Colorado Rockies with respect to their contribution to summer streamflow. (3) To test amount of drifted snow held by several snow fence patterns under high alpine conditions. Purpose is to determine most desirable pattern for snow fence installations to increase amount of snow deposited in alpine snowdrifts. (4) To measure the rate of snow accumulation in natural catchment basins under alpine conditions. This is the pretreatment calibration of a series of drift sites, part of which will be supplemented by drift fences at a later date to test the effectiveness of such structures in enlarging and deepening such alpine snow drifts.
(f) All active except (3) above, which has been temporarily suspended.
(g) The cutting and removal of half of the timber from one 714-acre watershed was completed in 1956. Eighty percent of this treatment was complete in 1955. The streamflow in 1956 was significantly increased by the timber removal. The apparent increase in water yield was 37 percent. The 1956 peak rate of discharge from spring snowmelt was also increased considerably, but in 1957 the peak was appreciably below that which would have occurred without the timber removal. Apparently weather sequences during the snowmelt period determine whether higher or lower peaks result from timber removal. The following data were taken for the third summer on an alpine snowfield in the Front Range of Colorado: Water equivalent, rate of depletion and relation between depletion rates and weather factors. A study of the moisture exchange between an alpine snow surface and the atmosphere showed that under conditions prevailing during the last of August 1957, the snow pack gained

moisture at the rate of 1,300 gallons of water per acre of snow per week. This study also showed a close agreement between the volume of melt water as computed from ablation and density and that measured from plastic lysimeters.

(h) Annual report, 1956, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

(657) WATERSHED MANAGEMENT RESEARCH, TEMPE, ARIZONA.

(b) Laboratory project.
(c) Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colo.
(d) Experimental; basic and applied research.
(e) The purpose is: (1) To study the disposition of rainfall as influenced by watershed vegetation; (2) to determine the influence of various types of forest and grassland vegetation as well as vegetation modified by cultural treatment such as grazing and timber harvest, on streamflow, water use, water loss, and erosion and sediment yield; (3) to determine for phreatophytic vegetation (water-loving plants) the amount of water used, methods for reducing water use by phreatophytes or for replacing them with more useful plants; and (4) for chaparral vegetation to determine the hydrologic characteristics of natural watershed, and the effect of cover modification upon water and sediment yields.

At Sierra Ancha Experimental Watersheds in central Arizona, rainfall, runoff, and erosion are measured on three watersheds in the pine-fir vegetation type at high elevation, on two watersheds in the ponderosa-chaparral type, and from four watersheds in the grassland-chaparral type at intermediate elevation, and on nine small watersheds in the semidesert-chaparral type at low elevations. Water use by different types of plants in various soils is studied on eleven large lysimeters. Three watersheds have also been established in the pure ponderosa pine type to test the effects of logging practices upon water yield and sedimentation. Gaging stations for four watersheds in the pure chaparral type are also available to evaluate watershed-game interrelations.

Ecology of Tamarix is under investigation. Germination, seedling survival, and rate of spread studies have been started. A field apparatus employing the infrared analyzer for detecting moisture has been developed for detailed measurement of evapo-transpiration.

(g) No significant increases in water yield have been detected from removing riparian vegetation amounting to 0.6 percent of the basal area on a watershed in the pine-fir type. A Villamonte type weir was installed to gage streamflow from a ponderosa pine watershed of about 10 sections. Pine roots were found at a depth of 12 feet in a pine forest. Chaparral watersheds were found to

yield streamflow from February until May. Number of shrub live oak sprouts was not materially reduced after five annual burns. Increases occurring after the first year were counteracted by decreases following the second, third, and fourth burns. Tamarisk seed has a short period of viability, and requires continuously wet soils for two or more weeks for establishment of seedling. Regulation of the water level and control of flood plains may be methods for discouraging spread of this plant.

(h) "A Method of Measuring Intact Plants Under Controlled Light, Humidity, and Temperature", J. P. Decker, and B. F. Wetzel, Forest Science, 1957 (In press).

(1967) WATERSHED MANAGEMENT RESEARCH, ALBUQUERQUE, NEW MEXICO.

(b) Laboratory project.
(c) Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colorado.
(d) Applied research.
(e) Evaluation of reseeded rangelands for infiltration, soil stabilization, and soil productivity in woodland-sagebrush zone of north central New Mexico.
Rocky Mountain infiltrometer was used to measure infiltration and erosion rates from reseeded and adjacent native rangelands under grazing and nonuse. Measurement of selected vegetation and soil factors included in this study.
(f) Field study completed. Conducted during summers of 1952, 1953, 1954, 1955, and 1956.
(g) Compilation and analyses completed on major effects.
(h) Annual reports of the Rocky Mountain Forest and Range Experiment Station.

(1968) WATERSHED MANAGEMENT RESEARCH, NORTH CENTRAL, NEW MEXICO.

(b) Laboratory project.
(c) Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colorado.
(d) Applied research.
(e) Range and watershed condition, trend, and potential in north central new Mexico. Rocky Mountain infiltrometer was used in 1953 and 1954 to measure infiltration and erosion rates from about 20 fenced-in enclosures installed in 1939 and 1940 on native pinyon-juniper sagebrush rangelands and from adjacent open range. Detailed soil and vegetation measurements were taken at each infiltrometer plot location. In addition, re-examination was made and quantitative measurement of vegetation taken, both inside and outside the enclosure, for comparison with measured conditions in 1939-40.
(f) Infiltrometer studies completed in 1953

and 1954.

(h) Station Paper, Rocky Mountain Forest and Range Experiment Station, summarizing findings planned.

(1969) WATERSHED MANAGEMENT RESEARCH, ALBUQUERQUE, NEW MEXICO.

(b) Cooperative study with Bureau of Land Management and Geological Survey.
(d) Applied research.
(e) Evaluation of range-watershed conditions on small watersheds in the San Luis drainage of the Rio Puerco. Three contiguous watersheds, ranging from 430 to 680 acres located about 8 miles north of the San Luis community and west of the Rio Puerco main channel provide the study area. Water and sediment inflow are measured in small reservoirs formed by earthen dams. Precipitation amounts and vegetation changes are periodically measured over the watersheds. The preliminary survey and investigation phase is completed; exterior boundary fences installed; and interior fences are under construction. Uniform grazing during a 6-month over-winter period (October 1 to April 1) at medium intensity of use will be practiced on all three watersheds for a 5-year period commencing October 1955. Thereafter, treatments will be applied to each of three watersheds as follows: Medium grazing use - no change; medium grazing use plus mechanical land treatments including gully control; and heavy grazing use.
(h) Annual reports of the Rocky Mountain Forest and Range Experiment Station.

(1971) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project, in cooperation with Bureau of Land Management, Bureau of Reclamation, Geological Survey, and Fish and Wildlife Service.
(c) Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colo.
(d) Experimental; applied research.
(e) To determine the effect of exclusion of livestock grazing on erosion and runoff from semidesert lands in western Colorado, eastern Utah, and southern Wyoming.
(g) Pretreatment measurements were made in 1953 and 1954 of infiltration and erosion, using the Rocky Mountain infiltrometer. Measurements during the period of treatment will be made at 5-year intervals, commencing in 1958.

(2188) WATERSHED MANAGEMENT RESEARCH, ALBUQUERQUE, NEW MEXICO.

(b) Laboratory project.
(c) Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colo.
(d) Applied research.
(e) Soil moisture studies. Colman soil electrical units are installed at 3-inch depth

intervals from the 1 1/2-inch soil depth to bedrock or to a depth beyond any anticipated moisture penetration. Recording and standard gages are used to measure precipitation. Moist pinyon-juniper zone (17-inch annual precipitation). A record of precipitation and soil moisture is maintained under three ground-cover conditions; under pinyon trees and in a woodland opening; in grassland; and in a bared area kept free of vegetation by chemical spraying. Dry pinyon-juniper-sagebrush zone (13-inch annual precipitation). A record of precipitation and soil moisture is maintained under four conditions: Native sagebrush under protection from livestock grazing, and in crested wheatgrass under 25 percent utilization, under 75 percent utilization, and under full protection from cattle grazing.
(h) Annual reports of the Rocky Mountain Forest and Range Experiment Station.

(2420) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project.
(c) Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colorado.
(d) Field investigation; applied research.
(e) Purpose of 1957 measurements is to compare the amount of soil moisture withdrawal under aspen, spruce, and a mixed grass-weed type. Three sites were sampled in each type. Seven gravimetric samples were taken at random on a 30-foot grid superimposed on each site. Samples were taken approximately July 1 and November 1, the difference in water content representing gross use by vegetation. Water use values will be adjusted for current precipitation. Samples were taken in 1-foot increments to a depth of 8 feet.

(2657) WATERSHED MANAGEMENT RESEARCH, GRAND JUNCTION, COLORADO.

(b) Laboratory project.
(c) Mr. Raymond Price, Director, Rocky Mountain Forest and Range Experiment Station, Room 221 Forestry Building, Fort Collins, Colorado.
(d) Field investigation; applied research.
(e) Purpose is to determine the effect of range conditions and related factors on sediment production and runoff on three mountain grassland watersheds in western Colorado. Range condition is being measured by means of 30 or more 3-step transects on each watershed. Ninety degree V-notch weirs are used to gage the watersheds which vary in size from 86 to 272 acres. Water samples are taken several times daily during snowmelt and periods of storm runoff for determination of suspended sediment; bed load is measured in the weir ponds. Measurement of all factors was started in 1956.

(2658)   WATERSHED MANAGEMENT RESEARCH, RAPID CITY,
         SOUTH DAKOTA.

    (b) Laboratory project.
    (c) Mr. Raymond Price, Director, Rocky Mountain
         Forest and Range Experiment Station, Room
         221 Forestry Bldg., Fort Collins, Colorado.
    (d) Experimental; basic and applied research.
    (e) (1) To determine how heavy grazing of blue-
         grass range in the Black Hills has influ-
         enced soil structure. The study involves
         measurement of bulk density and pore space
         of soil inside and outside of livestock
         enclosures. (2) To study basic soil-water
         relationships under dense ponderosa pine
         in the Black Hills and to determine how
         thinning influences amount of water availa-
         ble for streamflow. The study involves
         measurement of precipitation in the open,
         through-fall precipitation under thinned
         and unthinned pine, stem flow, and soil
         moisture.
    (g) Soil has significantly lower bulk density
         and greater detention pore space from the
         soil surface to 4 inches depth inside than
         outside enclosures protected from grazing
         for 10 and 17 years. There was little dif-
         ference from 4 to 12 inches. At enclosures
         protected from grazing for only 6 and 7
         years there was little apparent difference
         in the entire surface foot of soil inside
         and outside.
    (h) Annual report, 1956, Rocky Mountain Forest
         and Range Experiment Station, Fort Collins,
         Colorado.

(2913)   BEAVER CREEK WATERSHED PROJECT.

    (b) Laboratory project, cooperative with Coco-
         nino National Forest, Flagstaff, Ariz.
    (c) Mr. Raymond Price, Director, Rocky Mountain
         Forest and Range Experiment Station, Room
         221 Forestry Building, Fort Collins, Colo.
    (d) Field investigation; basic research.
    (e) Calibration of 12 small watersheds, 6 in
         the ponderosa pine type, 3 in the alligator
         juniper type, and 3 in the Utah juniper
         type. A newly designed modified trapezoidal
         Venturi flume is being used to measure dis-
         charge from these steep ephemeral streams.
    (g) A discharge estimated at 380 sec-ft occur-
         red on a pine watershed August 13, 1957.
         Complete photos were taken during the flow.
    (h) Report in preparation.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE,
Southeastern Forest Experiment Station.

  (380) WATER RESOURCE AND WATERSHED MANAGEMENT
         RESEARCH.

    (b) Laboratory project. For general public use
         and information.
    (c) Mr. J. F. Pechanec, Director, Southeastern
         Forest Experiment Station, U. S. Forest
         Service, P. O. Box 2570, Asheville, N. C.
    (d) General investigation of forest influences
         in the southeastern United States,

including fundamental hydrologic research
and applied research in watershed manage-
ment.
    (e) To determine the effect of forest vegeta-
         tion and land management practices on the
         components of the hydrologic cycle, includ-
         ing the effects on water yield and quality.
         To develop methods of watershed management
         which will result in the greatest benefit
         from the land and water resources of the
         southeastern United States.
         Most of the experiments and hydrologic
         data collection are carried out on the
         5600-acre Coweeta Hydrologic Laboratory,
         located in the zone of maximum precipita-
         tion in the eastern United States (Nanta-
         hala Range of the Southern Appalachians).
         Thirty-three individual watersheds whose
         streamflow is being continuously gaged
         provide the basis for the experimental pro-
         gram. The laboratory has 16 recording and
         69 non-recording (standard) rain gages, 8
         recording ground water wells, 8 recording
         hygrothermographs, 2 recording anemometers,
         and 2 evaporation pans. Water samples for
         quality analysis are collected from select-
         ed watersheds on a daily and storm period
         basis.
         On the Calhoun Experimental Forest, near
         Union, S. C., research is concerned with
         the problems and factors involved in re-
         habilitating Piedmont soils. Studies
         include measurement of the soil moisture
         regime under different cover types, and
         different densities of vegetation, hydro-
         logic properties of forest soils, and
         index values of runoff and sediment pro-
         duction from several small watersheds.
         The forest has 5 recording and 15 standard
         rain gages as well as a standard Weather
         Bureau weather station.
         Research projects include: (1) Evapo-
         transpiration from forest land; hydrologic
         effects of cutting timber stands with re-
         growth permitted; hydrologic effects of
         cutting timber stands with regrowth cut
         back each year; hydrologic effects of cut-
         ting laurel-rhododendron understory on a
         small mountain watershed; effect on water
         yield of cutting deep soil, cove-type
         vegetation; and hydrologic effects of re-
         ducing basal area 50 percent; (2) reha-
         bilitation treatment of experimental
         watersheds formerly used in studies of
         mountain farming, woodland grazing, and
         exploitive mountain logging; (3) type con-
         versions on drained slopes; comparative
         water yields from grass, conifer, and
         hardwood cover; (4) precipitation network
         requirements for small Southern Appala-
         chian watersheds; (5) soil moisture re-
         gime in relation to evapo-transpiration;
         (6) rainfall interception at Coweeta; and
         (7) operating forest pilot watersheds to
         demonstrate proper location and layout of
         logging roads.
    (g) Studies of woodland grazing, mountain
         farming and improper logging have demon-
         strated the extremely detrimental effects
         of poor land management on water quality

and storm peaks. Ten to fifteen years data furnish information on the time required for adverse effects to show up. Various types of forest cuttings on selected watersheds have yielded information on annual and seasonal water balance, storage and depletion of ground water, and the use of water by forest vegetation. For example, removing all forest vegetation from a small watershed gave increases in steamflow equivalent to 60 percent of the average pretreatment flow, with increases gradually subsiding as the forest regrew. Piedmont studies are showing that the organic layers of forest soil are a valuable diagnostic tool for timber and watershed magangment. Also through studies of soil moisture under different types of cover, information is being obtained regarding consumptive use of water, percolation rates, and seasonal storage potentials of forest soils.

(h) "A Guide to the Coweeta Hydrologic Laboratory", by Robert E. Dils, Southeastern Forest Experiment Station, pp 40, Sept. 1957.
"Annual Report of the Southeastern Forest Experiment Station."
"Effects of Land Use on Streamflow", Donald E. Whelan. Alabama Academy of Science Journal, Vol. 29, Sept. 1957.

U. S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE, Southern Forest Experiment Station.

(2914) WATERSHED MANAGEMENT RESEARCH TALLAHATCHIE RESEARCH CENTER, MISSISSIPPI.

(b) Laboratory project, in cooperation with the Soil Conservation Service and the Univ. of Mississippi.
(c) Mr. Philip A. Briegleb, Director, Southern Forest Experiment Station, 704 Lowich Bldg., 2026 St. Charles Avenue, New Orleans 13, Louisiana.
(d) Field investigation; basic and applied research.
(e) During 1957, nine small natural headwater catchments, two to four acres in size, were installed to determine rates and amounts of surface runoff and erosion from representative soil-cover complexes on forest and potential forest lands. Pretreatment calibration measurements will provide information needed for the planning and design of the watershed treatment program on the Yazoo-Little Tallahatchie basin in north Mississippi. After suitable calibration the hydrologic effects of remedial treatments, and changes in cover type will be measured. Three small watersheds are installed on each of three cover types with similar soils--abandoned old-fields; depleted upland hardwoods, and pole-size loblolly pine plantations growing on severely eroded sites.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Beach Erosion Board.

Inquiries concerning Projects Nos. 181, 660, 975, 976, 977, 2190, 2191, 2193, 2195, 2659, 2660, 2661, and 2915 to 2917, incl., should be addressed to the President, Beach Erosion Board, 5201 Little Falls Road, Washington 16, D. C.

(181) EQUILIBRIUM PROFILE OF BEACHES AND STUDY OF MODEL SCALE EFFECT.

(b) Laboratory project.
(d) Experimental.
(e) Equilibrium beach profiles will be determined experimentally for waves up to 6 feet in height in a prototype tank; the waves will be modeled at a 1 to 10 scale in small laboratory tanks for various median diameter sand sizes to determine scale effect.
(g) Profiles were determined for 2-, 4-, and 6-foot 11-second waves and for a 5-foot 6-second wave and for 1:10 and 1:15 models of these, using,however, the same sand size for both model and full scale tests. Results show that the deformation of a beach under wave attack is as much a function of absolute size of wave as of wave steepness; and that the laboratory determined initial value of deepwater wave steepness of about 0.025 determining whether a beach foreshore will erode or prograde may not apply to prototype conditions.
(h) "Scale Effects in Two Dimensional Beach Studies", T. Saville, Jr., International Association for Hydraulic Research (Lisbon, Portugal, Congress 1957) in press.

(660) OBSERVED WAVE CHARACTERISTICS.

(b) Laboratory and field project.
(d) Field investigation; basic research.
(e) To secure a more thorough knowledge of the characteristics of ocean waves. A number of electrical recording wave gages have been installed in coastal waters and these records are analyzed for significant height and period.
(g) A new wave recording station was installed at Steel Pier, Atlantic City, New Jersey. A new type plastic wave gage will be installed at this station for test purposes, in the near future.
(h) "Wave Statistics for the Gulf of Mexico off Brownsville, Texas", Beach Erosion Board Technical Memorandum No. 85, 25 pages, Sept. 1956.
"Wave Statistics for the Gulf of Mexico off Caplen, Texas", Beach Erosion Board Technical Memorandum No. 86, 25 pages, Sept. 1956.
"Wave Statistics for the Gulf of Mexico off Burrwood, Louisiana", Beach Erosion Board Technical Memorandum No. 87, 25 pages, Oct. 1956.
"Wave Statistics for the Gulf of Mexico off Apalachicola, Florida", Beach Erosion Board Technical Memorandum No. 88,

25 pages, Oct. 1956.
"Wave Statistics for the Gulf of Mexico off Tampa, Florida", Beach Erosion Board Technical Memorandum No. 89, 25 pages, Oct. 1956.

(975) METHODS OF BY-PASSING SAND PAST INLETS.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) To study methods and requirements for pumping sand past inlets and to determine the applicability of the methods in stabilization of beaches adjacent to inlets. In connection with this project a study is being made of the sand by-passing operation carried out by the Corps of Engineers at Port Hueneme, California in 1953 and 1954. Data, including hydrographic surveys and aerial photographs before, during, and at intervals after the dredging, and records of wave height and period are being studied to obtain any pertinent information on sand by-passing which may be applicable in future operations of this type.
(h) "Sand By-Passing at Port Hueneme, California", Rudolph P. Savage, Beach Erosion Board Technical Memorandum No. 92, March 1957.

(976) ESTABLISHMENT OF CRITERIA FOR CONSTRUCTION OF ARTIFICIAL BEACHES.

(b) Laboratory.
(d) Theoretical, applied research.
(e) The purpose of this project is to provide a method for determining optimum material to be used for beach fill.
(f) Reopened.
(g) A statistical method for the determination of the size characteristics of an existent beach from a limited number of samples is presented. Specifications for fill material may be derived from the size data.
(h) "A Method for Specification of Sand for Beach Fills", Dr. William C. Krumbein, Beach Erosion Board Technical Memorandum No. 102, 84 pages, Nov. 1957.

(977) DEVELOPMENT OF WAVE HEIGHT AND WAVE DIRECTION GAGES.

(b) Laboratory project.
(d) Experimental; development.
(e) To develop wave height and wave direction gages for use in securing accurate records of wave characteristics.
(g) Additional development of recording parallel wire resistance and capacitance gages for laboratory use has been made to obtain constant linear calibration characteristics. A plastic wave height gage has been fabricated for laboratory and field use in lieu of the neoprene coated aluminum channel type. A less expensive gage and longer life is expected. Preliminary laboratory experiments for a wave direction gage are under way. Progress not sufficient for definite conclusion - work is being carried forward.

(2190) STUDY OF EFFECT OF A GROIN SYSTEM ON THE RATE OF LITTORAL MOVEMENT.

(b) Laboratory project.
(d) Experimental; basic research.
(e) To study the effect of groins on the rate of littoral drift passing a groin system. Installation of test setup in the Shore Processes Test Basin has been completed. Initial tests consist of waves generated at 30-degree angle to the sand beach. Measurement of material movement is being made at the down-beach end.
(g) A total of 5 tests were made during the year, each 50 hours in length. The first test established the drift rate along the beach with no groins as approximately 330 lbs per hour (dry weight). One low short groin temporatily reduced the drift rate about 12% and a high groin of the same length temporarily reduced the drift rate about 25%. A long high (barrier) groin temporarily reduced the drift rate about 50%.

(2191) SAND MOVEMENT AT MORICHES INLET, LONG ISLAND, NEW YORK.

(b) Laboratory project.
(d) Field investigation; basic research.
(e) To investigate the pattern of movement and deposition of the littoral materials in the vicinity of a newly opened inlet. Movement of the littoral material is being traced by means of hydrographic surveys of both the ocean and bay sides of the inlet, and through variation in size characteristics and heavy mineral composition of the littoral material. An attempt is being made to correlate movement of the littoral material with the natural forces involved.

(2193) SHORE PROTECTION PLANNING AND DESIGN.

(b) Laboratory project.
(d) Design.
(e) The purpose of this project is to supplement and revise the Beach Erosion Board's Technical Report No. 4, "Shore Protection Planning and Design" as new data and techniques are developed for use in the solution of coastal engineering problems.
(g) The first addenda sheets to Beach Erosion Board Technical Report No. 4 were compiled and dispatched to recipients of this repot.
(h) "Corrections, Revisions, and Addenda for Technical Report No. 4, Shore Protection Planning and Design", Beach Erosion Board, August 1957.

(2195) RE-EXAMINATION OF ARTIFICIALLY NOURISHED AND CONSTRUCTED BEACHES.

(b) Laboratory project.
(d) Field investigation; applied research.
(e) The purpose of this project is to study the behavior of beach fills which have been placed to nourish and protect

adjacent shores. A selected number of lo-
cations where beach fills have been made
are being re-examined.

(2659) WAVE FORCES ON PILES.

(b) Laboratory project.
(d) Experimental; applied research, design.
(e) The purpose of the study is to determine
the nature and magnitude of forces on piles
caused by breaking and non-breaking waves.
(f) Additional testing is planned.
(g) Forces as high as 300 lbs per foot have
been observed on a pile 12 3/4 inches in
diameter with breaking waves about 6 feet
high. Non-breaking waves about 4 feet high
caused forces on the pile as high as 30 lbs
per foot. Preparation of the report is
currently in progress.

(2660) WAVE TANK STUDY OF QUANTITY OF SAND IN
SUSPENSION IN THE SURF ZONE (INCLUDING
TEMPERATURE EFFECTS).

(b) Laboratory project.
(d) Experimental; basic research.
(e) A vacuum pump type suspended sediment samp-
ler will be used to collect suspended sand
samples under various conditions of waves,
water temperature and sand. A large field
sampler will be used to obtain suspended
samples in the prototype wave tank. The
purpose of the study is to determine the
relationships between wave, water, and sand
characteristics and the amount of material
maintained in suspension and hence available
for longshore transport by currents.
(g) Surf zone suspended sampling has been car-
ried out in the prototype wave tank for
waves from 2 to 6 feet in height. Wave
periods were 11.33 and 16.0 seconds in
water depths of 2 to 10 feet. Concentra-
tions up to 28 PPT have been measured.
Suspended samples collected in the Shore
Processes Test Basin under waves of 0.25
feet in height and 1.4 to 1.75 second
period reflect concentration of 0.1 to 10
PPT. Lower water temperatures in wave
action sampling tends to increase the mean
grain size and the total quantity of sedi-
ment in suspension.

(2661) WAVE RUN-UP ON SHORE STRUCTURES.

(b) Laboratory project.
(d) Experimental; design.
(e) Wave run-up is determined experimentally
by various waves for different types of
shore structures. Effect of both structure
roughness and permeability is being inves-
tigated.
(g) Wave run-up on roughened structures has
been related to the deep water wave steep-
ness, beach or structure slope, and median
diameter of the roughness material. Wave
run-up on permeable slopes has been related
to the deep water wave steepness, beach or
structure slope, and the permeability in
ft^2 of the slope material.
(h) "Wave Run-Up on Roughened and Permeable

Slopes", Rudolph P. Savage, Paper present-
ed at October 1957 American Society of
Civil Engineers meeting.

(2915) COASTAL DUNE STABILIZATION BY VEGETATION.

(b) Laboratory.
(d) Field and laboratory investigation; ap-
plied research.
(e) The purpose of this project is to compile
all available data and information on the
techniques for stabilizing coastal dune
formation by vegetation.
(f) Completed.
(g) Various species of vegetation are recom-
mended for use in coastal dune stabiliza-
tion for zones landward of mean high water
and for various climate sectors.
(h) "Dune Formation and Stabilization by Vege-
tation and Plantings", Dr. John H. Davis,
Beach Erosion Board Technical Memorandum
No. 101, 59 pages, Oct. 1957.

(2916) WAVE FORECASTING RELATIONSHIPS AND TECH-
NIQUES.

(b) Laboratory project.
(d) Theoretical and field investigation.
(e) To select and evaluate new methods of wave
forecasting to be used in determining the
design wave for offshore structures. To
expand and improve current methods of wave
forecasting for specific application to
the design of hurricane protective struc-
tures.
(g) Methods have been presented for computing
the significant wave (average of highest
1/3) and the maximum waves for a hurricane
moving from deep water over a Continental
Shelf to the coast.
A method for obtaining hurricane storm
surge is presented.
Theoretical formulae and empirical data
have been adapted and modified for use in
the selection of a design wave for off-
shore structures. Selection of a design
wave requires data on the design wave
height, period, crest elevation and wave
length.
Work is in progress on the revision of
wave forecasting techniques.
(h) "Wave Forecasting Relationships for the
Gulf of Mexico", Beach Erosion Board
Technical Memorandum No. 84, 28 pages,
Dec. 1956, C. L. Bretschneider.
"Hurricane Wave Statistics for the Gulf
of Mexico", Beach Erosion Board Technical
Memorandum No. 98, 61 pages, June 1957,
B. W. Wilson.
"Hurricane Design Wave Practices", pro-
ceedings of the American Society of Civil
Engineers, Vol. 83, No. WW2, paper 1238,
May 1957, 33 pages, C. L. Bretschneider.
"Selection of Design Wave, for Offshore
Structures" presented at the 1957 annual
convention of the American Society of
Civil Engineers, October 14 - 18, 1957,
C. L. Bretschneider.
"Revisions in Wave Forecasting Techniques",
Sixth International Conference on Coastal

Engineering, Gainesville, Florida, Dec. 2, 1957, C. L. Bretschneider.

(2917) MODEL STUDY OF WAVE RUN-UP AND OVERTOPPING ON LAKE OKEECHOBEE LEVEES.

(b) U. S. Army Engineer District, Jacksonville, Florida.
(d) Model study; for design.
(e) A 1 to 2.5 scale model of the proposed Lake Okeechobee levee design (1 on 3 and 1 on 6 slopes) will be tested under wave action up to 4 feet in height (10 feet prototype) to determine heights of wave run-up and quantities of wave overtopping for two crest elevations. Results will be compared with those in smaller laboratory flumes (1 to 30 model) to determine existence of any scale effect.
(g) Preliminary results (initial test only) indicate that overtopping is greater and there is a scale effect in such tests in that the small-scale model indicates less overtopping (to scale) than the large-scale model.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Bonneville Hydraulic Laboratory.

Inquiries concerning Projects Nos. 1462, 1464, and 1466 should be addressed to District Engineer, U. S. Army Engineer District, Portland, 628 Pittock Block, Portland 5, Oregon.

(405) GENERAL MODEL STUDY OF ICE HARBOR DAM, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.
(c) District Engineer, U. S. Army Engineer District, Walla Walla, Building 602, City-County Airport, Walla Walla, Washington.
(d) Experimental; for design.
(e) A 1:100-scale, undistorted, fixed-bed model reproduces 2.7 miles of the Snake River at the dam site. The proposed structures include a 6-unit powerhouse (3-unit initial installation), 10-bay (tainter-gate control-led) spillway, 86- by 675-foot navigation lock and facilities for migrant fish. The latter include two 1 on 16-slope fish ladders, 16 feet wide on north bank and 24 feet wide on south bank, and a powerhouse collection system. Auxiliary flow for both ladders and collection system will be provided by low-head pumps. Studies will be made to determine flow conditions during various construction stages and with proposed structures installed.
(g) Tests of first-step cofferdam were completed. Results indicated that realignment of upstream corner of cofferdam would reduce backwater effect and lower water-surface elevations along face of cofferdam. Movable bed studies were made to assist in estimating amount and location of erosion in prototype. Effect of rock groins along river bank opposite cofferdam were

investigated as an aid to fish migration during first-stage construction. General flow conditions were observed with the proposed structures installed. Three tailrace alinements were investigated and tests were made to determine best alignment of north fish ladder wall. Two-foot sills installed in end bays of spillway provided downstream flow at spillway entrances to fishways. Second-stage cofferdam tests were begun and indicated that improved entrance conditions to temporary fish ladder and reduced velocities along downstream fill could be obtained by realigning downstream lag of cofferdam.
(h) Five memorandum reports have been issued; three are in preparation.

(406) MODEL STUDY OF ICE HARBOR SPILLWAY, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.
(c) District Engineer, U. S. Army Engineer District, Walla Walla, Building 602, City-County Airport, Walla Walla, Washington.
(d) Experimental; for design.
(e) The 1:40-scale model consists of a 3-bay section of the 10-bay spillway. Tests were made to determine hydraulic performance of the proposed spillway and stilling basin and to develop revisions in design that would improve performance or reduce construction and maintenance costs.
(f) Tests completed.
(g) Satisfactory design of spillway and stilling basin and determination of crest rating, pressure data, and method of gate operation were accomplished.
(h) Two memorandum reports have been issued.

(407) MODEL STUDY OF ICE HARBOR NAVIGATION LOCK, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.
(c) District Engineer, U. S. Army Engineer District, Walla Walla, Building 602, City-County Airport, Walla Walla, Washington.
(d) Experimental; for design.
(e) Two models are being used to test performance of the proposed design for the hydraulic system and develop modifications for improvement if necessary. A 1:25-scale model will reproduce the 86- by 675-foot lock chamber, culvert systems, and portions of the upstream and downstream approach channels. A 1:16-scale model of a single lateral culvert of the lock filling system was used to determine designs that will produce uniform flow distribution from the culvert ports.
(f) Active.
(g) Lock model is under construction; tests on lock lateral model have been completed.
(h) Memorandum report on lock lateral tests is in preparation.

(1462) GENERAL MODEL STUDY OF THE DALLES DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) U. S. Army Engineer District, Portland, Corps of Engineers, Portland, Oregon.

(d) Experimental; for design.

(e) A 1:80-scale, undistorted, fixed-bed model reproduces 2.7 miles of the Columbia River at the dam site. The original layout consisted of a circular-arc, 30-bay spillway, a 22-unit powerhouse, an 86- by 675-foot navigation lock, a rock-fill nonoverflow section, and facilities for passing fish over the dam. Maximum head is 90 feet. Revised layout has a straight 23-bay spillway. Purposes are to study the structures alinement and flow conditions affecting navigation, power generation, cofferdam placement, rock-fill dam construction, and fish passage.

(f) Tests completed.

(g) Four major layout plans were tested and the most economical plan that effected satisfactory hydraulic conditions was selected. Tests indicated ability to reduce length of spillway and to reduce forebay excavation by 30 feet. Data relative to water-surface elevations and velocities in the tailrace, and the effects of excess fill placed in the forebay have been obtained. Flow conditions during various stages of construction and with the project completed have been observed with special attention given to navigation and fish migration problems. Tests were conducted to compare flow conditions in model and prototype with the 1957 peak discharge of 643 500 cfs when all flow was through spillway. Test was repeated with five powerhouse units operating - expected installation at time of 1958 high water.

(h) Twenty-nine memorandum reports have been issued; one is in preparation.

(1464) MODEL STUDY OF ROCK FILL, THE DALLES DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) U. S. Army Engineer District, Portland, Corps of Engineers, Portland, Oregon.

(d) Experimental; for design.

(e) The 1:40-scale model of the 500-foot-wide closure section of the rock-fill nonoverflow section of the Dalles Dam included portions of the river channel upstream and downstream therefrom and the eight partially-completed units at the upstream end of the powerhouse through which the river flow was diverted as the closure fill was constructed. A study of the rock sizes and placement procedure required to construct the fill at a river flow of 200 000 cfs and for stability at 300 000 cfs was made.

(f) Tests completed.

(g) The fill has been constructed by placing quarry-run rock (1000 lb and less) in 10-foot lifts or by end-dumping from the Oregon shore at river discharges of 200 000 cfs and less. Owing to the faster placing program possible with the end-dump procedure, studies were concentrated on this method of closure. The 1000 lb and smaller material was placed without loss in bottom velocities of 17 fps and surface velocities of 24 fps. The higher velocities caused some movement of material but owing to the 250-foot width of fill the material did not move beyond the confines of the fill. Flow data were obtained during the prototype closure for correlation with model data. A model check of three stages of the prototype closure showed good agreement of flow conditions.

(h) Twelve memorandum reports have been issued in addition to a summary report to supply information to prospective bidders.

(1466) MODEL STUDY OF THE DALLES DAM NAVIGATION LOCK, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) U. S. Army Engineer District, Portland, Corps of Engineers, Portland, Oregon.

(d) Experimental; for design.

(e) A 1:25-scale model of the 86- by 675-foot lock chamber including its culvert systems and portions of the upstream and downstream approach channels was reproduced. Maximum lift is 90 feet. Studies were made of various types of filling and emptying systems to determine the most advantageous design from the standpoints of rate of operations, degree of turbulence, and economy. The several proposed plans included lateral culverts within the lock chamber combined with several locations of intake ports, longitudinal culverts, and outlet ports.

(f) Tests completed.

(g) Designs have been selected for all features of the lock. A valve-opening schedule of 4 minutes resulted in a filling time of 12.5 minutes and a maximum hawser force of 8 tons without supplemental use of the upstream lock tainter gate. The lock emptied in 16 minutes. Studies have shown that staggered valve operation will reduce maximum hawser stresses. Operational tests of the final design were made with several heads and barge positions using a 4-minute valve-opening schedule. One combination of head and barge position corresponds to expected conditions of prototype tests to be performed in Dec. 1957.

(h) Six memorandum reports have been issued and two are in preparation.

(2662) GENERAL MODEL STUDY OF JOHN DAY LOCK AND DAM, COLUMBIA RIVER, OREGON AND WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.

(c) District Engineer, U. S. Army Engineer District, Walla Walla, Building 602, City-County Airport, Walla Walla, Washington.

(d) Experimental; for design.

(e) A fixed-bed model constructed to an undistorted 1:80-scale will reproduce the Columbia River from Mile 213.7 to 216.8. The structures will be at approximately Mile 215.5. Investigation of flow conditions will be conducted for construction

stages and for completed project in the interests of design, navigation, fish migration, and power.

(g) Construction of model and verification test have been completed.

(2664) MODEL STUDY OF EAGLE GORGE TUNNEL, GREEN RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Seattle, Corps of Engineers, Seattle, Washington.

(c) District Engineer, U. S. Army Engineer District, Seattle, 4735 East Marginal Way, Seattle 4, Washington.

(d) Experimental; for design.

(e) A 1:25-scale model of regulating tunnel reproduced the tunnel intake, one emergency gate, control valves, approximately 700 feet of 500-foot-radius, 22- by 22-foot horseshoe tunnel, stilling basin, and outlet channel.

(f) Tests completed.

(g) Tests showed that center pier of intake section could be reduced in length without adversely affecting flow conditions. Original stilling basin was changed to a nonbaffled type, floor elevation lowered 6 feet, and a 45-degree end sill used to allow unimpeded passage of rocks through structure. Pressure, water-surface, velocity, and valve rating data were obtained for all anticipated operating conditions. Although hydraulic downpull on an emergency closure gate could not be measured directly for prototype conditions, maximum values of downpull, as computed from pressures indicated in the model, ranged from 177 to 186 kips.

(h) Five memorandum reports have been issued.

(2665) MODEL STUDY OF ICE HARBOR POWERHOUSE INTAKE GATES, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Washington.

(c) District Engineer, U. S. Army Engineer District, Walla Walla, Building 602, City-County Airport, Walla Walla, Washington.

(d) Experimental; for design.

(e) The 1:25-scale model contains a test unit consisting of intake and scroll case with emergency closure gates and gate slots. The middle closure gate is reproduced in plastic with a synchronous-motor-operated lifting mechanism to simulate prototype operating speed. Provision was made to measure pressures on the gate lip with several lip designs. Tests are being made to determine the gate design producing the least downpull force during emergency closure.

(g) Tests have been made on a 1:25-scale model of one unit of Chief Joseph powerhouse to correlate model downpull forces on intake gate with tests made at Chief Joseph powerhouse during 1955. Correlation was made to obtain a basis for evaluating tests of Ice Harbor powerhouse intake gates. The powerhouse intake gate for Ice Harbor Project has been tested with 12- and 20-inch

lip extensions and with a 45-degree lip.

(h) Memorandum report on Chief Joseph tests has been issued. Report of Ice Harbor test is in preparation.

(2666) MODEL STUDY OF ICE HARBOR DAM FISH LADDERS, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.

(c) District Engineer, U. S. Army Engineer District, Walla Walla, Building 602, City-County Airport, Walla Walla, Washington.

(d) Experimental; for design.

(e) A 1:10-scale model reproduces a 41-pool tangent of the 1 on 16 slope, 24-foot-wide, south fish ladder in addition to the 6-pool orifice control section of the south fish ladder. Investigations are concerned with fish ladder surge and its elimination and the size and locations of orifices in the control section (no overflow) to function with a 5-foot change in pool elevation without creating undesirable flow conditions. Model was modified to include 16-foot-wide orifice control section and pools of 16-foot-wide 1 on 16 slope fish ladder to check design of orifice control section and determine flow characteristics in typical fish ladder pool.

(f) Tests completed.

(g) Results with 24-foot-wide ladder indicated that surge would occur within operating range of fish ladder unless a weir crest approximating a sharp edge was used. Surge was reduced with a contracted weir. Uniformity of heads in control section was obtained by varying the spacing of orifices in alternate baffles. Flow conditions in typical pool of 16-foot-wide ladder were satisfactory and plunging flow continued to a head of approximately 15 inches on a weir. Uniformity of heads in control section of 16-foot-wide ladder was obtained by varying the spacing of the two orifices in each baffle.

(h) Two memorandum reports have been issued; one is in preparation.

(2918) MODEL STUDY OF NORTH HARTLAND DAM, OTTAUQUECHEE RIVER, VERMONT.

(b) U. S. Army Engineer Division, New England, Corps of Engineers, Boston, Massachusetts.

(c) Division Engineer, U. S. Army Engineer Division, New England, 150 Causeway St., Boston 14, Massachusetts.

(d) Experimental; for design.

(e) A 1:50-scale, fixed-bed model reproduces a portion of the 185-foot-high, 1520-foot-long earth embankment dam, sufficient forebay area and topography to simulate natural flow conditions, and the 450-foot-long spillway crest and 50-foot-wide trapezoidal side channel through the left abutment of the dam. The spillway is designed to pass a maximum flood of 160 900 cfs under a head of 20.3 feet. The study is necessary to insure that the spillway of adopted design will be economical to

construct and will perform satisfactorily.

(f) Tests completed.

(g) Although the original design straight crest was satisfactory, tests showed that an L-shaped crest 485 feet in length would be adequate and would require less rock excavation.

(h) Two memorandum reports are in preparation.

(2919) MODEL STUDY OF CHANNEL IMPROVEMENT PLANS, PALOUSE RIVER, COLFAX, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.

(c) District Engineer, U. S. Army Engineer District, Walla Walla, Bldg. 602, City-County Airport, Walla Walla, Washington.

(d) Experimental; for design.

(e) A 1:40-scale flume model will be used to determine the extent of channel enlargement and modification, levees, flood walls, and revetments necessary to protect the town of Colfax, Washington, from the following higher-than-record discharges: 14 500 cfs in the South Fork, 16 800 cfs in the Palouse River above the mouth of the South Fork, and 28 000 cfs in Palouse River below the mouth of the South Fork. Space limitations require sharply curved channels of varying cross section which are further restricted by bridge piers at several locations.

(g) Model design and construction have been initiated.

(2920) MODEL TESTS OF SERVICE GATE SEALS, EAGLE GORGE DAM, GREEN RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Seattle, Corps of Engineers, Seattle, Washington.

(c) District Engineer, U. S. Army Engineer District, Seattle, 4735 East Marginal Way, Seattle 4, Washington.

(d) Experimental; for design.

(e) A square bulb, "J" type rubber seal with and without a brass chafing strip cast into the bulb will be tested to determine: (1) maximum satisfactory clearance between retainer bar and sealing plate; (2) maximum seal and support plate clearance that will be closed by the force from the top seal; and (3) friction factors. Heads of 100, 150, and 200 feet will be tested.

(g) Construction of apparatus has been initiated.

(2921) MODEL STUDY OF ICE HARBOR SPILLWAY STOP LOG, SNAKE RIVER, WASHINGTON.

(b) U. S. Army Engineer District, Walla Walla, Corps of Engineers, Walla Walla, Wash.

(c) District Engineer, U. S. Army Engineer District, Walla Walla, Bldg. 602, City-County Airport, Walla Walla, Washington.

(d) Experimental; for design.

(e) A 1:20-scale model of a single bay of Ice Harbor spillway dam will be installed in an existing Laboratory flume. Structural features of stop log will be reproduced and facilities will be provided for direct

measurement of hydraulic load on stop log as it is lowered into place in high velocity flow.

(g) Design and construction will be initiated.

DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, Los Angeles District.

Inquiries concerning Projects Nos. 1732, 2198, 2667, and 2922, should be addressed to U.S. Army Engineer Dist., Los Angeles Corps of Engineers, P.O. Box 17277, Foy Sta., Los Angeles 17, Calif.

(1732) MODEL STUDY OF SAN ANTONIO OUTLET WORKS CHANNEL.

(b) Laboratory project.

(d) Experimental for design.

(e) The outlet channel which will carry discharges from the 14.5-foot diameter tunnel of San Antonio Dam will be 14.5 feet wide, curved in alinement, and will carry the design discharge of 8,000 cfs at a depth and velocity of 9 feet and 61 fps, respectively. A diversion structure to turn out flood flows from the high velocity channel for conservation use is required. The intake for the proposed diversion consists of a slotted opening across the bottom of the outlet channel. Flow passing through the slot will enter a chamber under the channel. Discharge from the chamber will be regulated by slide gates, 4 feet wide by 4 feet high. There will be four gates on the left side to pass 600 cfs, and two gates on the right side to pass 300 cfs. Test of the design are being conducted in a 1:20-scale model.

(g) Results indicated satisfactory flow conditions in all portions of the structure.

(2198) MODEL STUDY OF SUPERELEVATED FLOW IN CURVED TRAPEZOIDAL CHANNELS.

(b) Laboratory project.

(d) Experimental for design.

(e) Tests are being conducted in curved trapezoidal channels to determine the characteristics of flow, and the effectiveness of spiral easement curves in maintaining equilibrium of flow in the curve and in the downstream tangent. A 1:25-scale model having a base width of 62.5 feet, side slopes of 1 on 2.25, a curve with centerline radius of 885 feet, and spiral easement curves 325 feet long at the beginning and end of the circular curve, is being used for the tests. Tests were conducted with discharges of 35,000 cfs and 45,000 cfs in which the velocity of flow was 35 fps and 43 fps, respectively.

(2667) MODEL STUDY OF SANTA ANA RIVER LEVEES AT RIVERSIDE, CALIFORNIA.

(b) Laboratory project.

(d) Experimental for design.

(e) The Santa Ana River is an alluvial stream which carries considerable bedload during floods. Rock revetted levees having a 1 on 2 side slope are proposed to confine the design flood of 195,000 cfs. Two bridges are located 1,300 feet apart. The left levee is continuous upstream and downstream from the bridges, and the right levee extends downstream from the abutment of the upstream bridge to form a trapezoidal channel having a base width of 930 feet. Flow will be subcritical upstream from the bridges, and supercritical downstream from the bridges. Tests are being conducted in a movable bed model having a horizontal scale ratio of 1:120 and a vertical scale ratio of 1:40 to determine relative scour due to alinement of levees and bridge piers.

(g) Stone protection was added to prevent scouring along the right abutment of the upstream bridge. Further investigations to be conducted on relative scour around bridge piers of the upstream bridge.

(2922) MODEL STUDY OF WALNUT CREEK INLET CHANNEL.

(b) Laboratory project.
(d) Experimental for design.
(e) Walnut Creek Inlet Channel consists of a trapezoidal transition channel 1,000 feet in length. The upstream end is connected to a 110 foot rectangular concrete channel. The downstream end joins a natural 350 foot wide trapezoidal channel with grouted stone side slopes 1 on 2. Velocities for a discharge of 40,000 cfs range from 35 fps at the upstream end to 13 fps at the downstream end of the transition. Tests were conducted in a 1:60-scale model to determine the stability of the loose stone in the transition, and the relative scour occurring in the invert just downstream of the transition.
(f) Tests completed.
(g) A satisfactory design was obtained by lining the invert of the transition with grouted stone for the first 300 feet and dumped stone for the remaining 700 feet. Scouring of the natural stream bed immediately downstream from the end of the transition was negligible.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS, St. Paul District.

IN COOPERATION WITH ST. ANTHONY FALLS HYDRAULIC LABORATORY.

Inquiries concerning Projects Nos. 194, 412, 985, 2670, 2923, and 2924 should be addressed to the District Engineer, U. S. Army Engineer District, St. Paul, 1217 U. S. Post Office and Custom House, St. Paul 1, Minnesota.

(194) A STUDY OF METHODS USED IN THE MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS.

(b) Subcommittee on Sedimentation, Inter-Agency Committee on Water Resources.

(d) Experimental; applied research and development.

(e) Plans and specifications to facilitate the manufacture of suspended sediment and bed material samplers, particle size analyzers and associated laboratory apparatus have been prepared. Approved designs available include a hand operated sediment sampler weighing 4 pounds, a medium weight sediment sampler (62 pounds), heavy sediment samplers (100 and 300 pounds), a sediment sample splitter, a bottom withdrawal tube, a hand operated bed material sampler, a heavy bed material sampler (100 pounds), and a particle size analyzing apparatus using visual-accumulation sedimentation tubes for sand samples.

(g) Tests are in progress on an automatic single-stage suspended sampler for flashy and intermittent streams. Prototype tests on an intermittent pumping and settling type sampler were started at a field testing station. Tests are progressing on experimental apparatus developed for determining suspended sediment concentration and particle size distribution by means of pressure differential and acoustical devices.
Report No. 12, "Some Fundamentals of Particle Size Analysis", is ready for reproduction.

(h) "Automatic Single-Stage Sampler", Byrnon C. Colby, 17 pages, dated November 27, 1956.
"The Development and Calibration of the Visual-Accumulation Tube", report No. 11, 109 pages, 1957.

(412) ST. ANTHONY FALLS LOCKS.

(b) U. S. Army Engineer District, St. Paul.
(d) Experimental; for design.
(e) The lower lock has a single-culvert system and chamber laterals; the upper lock has culverts in each side wall and chamber laterals alternating from the two culverts. The two locks will have lifts of 25 and 49 feet, respectively. Tests were made on the hydraulic system for the upper lock in a model at a scale of 1:22.4.
(f) Testing completed.
(g) The upper lock will have intake manifolds located in both sides of the upstream approach walls to alleviate adverse currents at the lock entrance. Model tests showed that the lock could be filled in 8 minutes and that the maximum hawser pull on a tow would be about 2 tons. The emptying system provides a split discharge to reduce turbulence in the lower approach bay. The land wall culvert will discharge into the lower approach through diffusers and the river wall culvert discharges into a stilling basin riverward of the lock.
(h) Final report is being prepared.

(985) FILLING AND EMPTYING SYSTEMS FOR HIGH-LIFT LOCKS.

(b) Office, Chief of Engineers, U. S. Army,

Washington, D. C.
(d) Experimental; applied research.
(e) To develop adequate criteria for the de-
sign of filling and emptying systems for
high-lift locks. Tests will be conducted
in prototype locks, in model locks for
definite projects, and in a general lock
model simulating a maximum lift of 150
feet.
(g) Sinkage tests were made in the general
model on tows moving out of the lock.
Sinkage was recorded by linear transducers
at midlength of chamber and at the lower
sill on tows moving 0.66 to 3.0 miles/hour
(prototype). Factors affecting sinkage
included the draft and size of tow, its
speed, the width of lock, and the depth of
water over the sill.

(2670) MODEL STUDY OF FILLING AND EMPTYING SYSTEM
FOR JACKSON LOCK, TOMBIGBEE RIVER, ALABAMA.

(b) U. S. Army Engineer District, Mobile.
(d) Experimental; for design.
(e) The model was built to a scale of 3 to 100--
simulating a lock 110 feet wide by 670 feet
long with a lift of about 34 feet. The per-
formance of the proposed design of the hy-
draulic system was tested and modifications
to improve performance were developed.
(f) Testing completed.
(h) Final report in preparation.

(2923) FILLING AND EMPTYING SYSTEMS FOR FORT
GAINES LOCK, CHATTAHOOCHEE RIVER.

(b) U. S. Army Engineer District, Mobile.
(d) Experimental; for design.
(e) The Fort Gaines Lock will be 82 feet wide
by 450 feet long with a lift of 88 feet.
The filling and emptying systems include
sill intakes, side wall culverts, a split
system of chamber laterals, and discharge
outlets located riverward of the lock and
downstream from the spillway section of
the dam. Because of poor foundation ma-
terial at the site, lock culverts will not
be located at a low elevation relative to
the downstream pool. It is planned to
have the culverts submerged only 8 feet
below tail water.
A section of the culvert at the valve was
tested in a pilot model at a scale of 1 to
24.24 to determine whether the culvert im-
mediately downstream should be modified to
alleviate low pressures. The complete
hydraulic system is being tested in a
general model at a scale of 3 to 100.
(f) Testing is in progress.

(2924) MODEL STUDY OF FILLING AND EMPTYING SYSTEMS
FOR BARKLEY LOCK, CUMBERLAND RIVER.

(b) U. S. Army Engineer District, Nashville.
(c) Experimental; for design.
(e) The Barkley Lock will be 110 feet wide and
800 feet long with a dual culvert system
and a maximum lift of 73 feet. Intake port
manifolds will be located in the upstream
approach walls and bottom lateral culverts

in the lock chamber. Both culverts will
discharge into the filling basin of the
adjoining spillway. Tests in the model,
built to a scale of 3 to 100, will deter-
mine the adequacy of the hydraulic system
and develop necessary improvements.
(f) Testing is in progress.

U. S. DEPARTMENT OF THE ARMY, CORPS OF ENGINEERS,
Waterways Experiment Station.

Inquiries concerning the following projects should
be addressed to The Director, Waterways Experiment
Station, Corps of Engineers, P. O. Box 631, Vicks-
burg, Mississippi.

(218) CONDUIT INTAKE MODEL TESTS.

(b) Office of the Chief of Engineers, Depart-
ment of the Army, Washington, D. C
(d) Experimental; applied research.
(e) Scale models are being used for a general
study of the hydraulic characteristics of
entrance curves for (1) a gated tunnel
having a rectangular entrance with floor
at same elevation as approach channel
(entrance flared in three directions),
and (2) a rectangular conduit in which
parallel side walls are extended upstream
from the entrance and only the roof is
flared (entrance floor at same elevation
as approach channel). Tests involve de-
termination of pressures and discharge
coefficients. A study of rectangular con-
duits with entrance flared in four direc-
tions has been completed.

(230) MODEL STUDY OF FLOOD CONTROL, CUMBERLAND,
MARYLAND.

(b) District Engineer, U. S. Army Engineer
District, Washington, Corps of Engineers,
Washington, D. C.
(d) Experimental; for design.
(e) A fixed-bed, 1:60 model of the critical
portions of Wills Creek and the North
Branch of the Potomac River was used to
study and develop proposed plans for pro-
tection of Cumberland from floods. The
principal design problems centered around
the determination of satisfactory side-
wall alinements, bridge pier and abutment
designs, and junction design, adequate
stilling basin below industrial dam, and
amount of dredging that can be eliminated
below the industrial dam. The model was
adjusted hydraulically to reproduce three
floods of record.
(f) Completed.
(g) The final plan developed from the model
tests resulted in lowering stages below
the confluence of Wills Creek and North
Branch by about 3 feet by increasing chan-
nel capacity, and in permitting the use of
a relatively high velocity channel through
the lower reaches of Wills Creek without
the need for excessively high side walls.
(h) "Flood Protection Plans for Cumberland, Md.

and Ridgeley, West Virginia; Hydraulic Model Investigation", Waterways Experiment Station Technical Report No. 2-448, Jan. 1957. (Available on loan.)

(236) MISSISSIPPI BASIN MODEL.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; for design.
(e) The project provides for construction and operation of a model of the Mississippi River Basin including the Mississippi, Ohio, Missouri, White, Arkansas, and Red Rivers, and their principal tributaries. All existing and proposed flood-control reservoirs, dikes, floodwalls, and other pertinent works will be reproduced. The model area comprises 200 acres, and measures 4,500 feet east and west, and 3,900 feet north and south. Completed construction consists of the Upper Mississippi River from Hannibal, Missouri, to Tiptonville, Tennessee; the Missouri River from Sioux City, Iowa, to the mouth; the Arkansas River from Blackburn Dam Site, Oklahoma, to Pine Bluff, Arkansas; the Ohio River from Louisville, Kentucky to the mouth; the Cumberland River from Old Hickory Dam, Tennessee, to the mouth; and the Tennessee River from Pickwick Dam to the mouth. The topography of the streams and flood plains are being reproduced to a horizontal scale of 1:2,000 and vertical scale of 1:100. Water-surface elevations are measured by electrically operated stage devices with the recorders located in central control buildings. Stream flow is introduced and controlled by automatic instruments called inflow controllers. The model was designed to aid in the development of coordinated basin-wide plans for flood control and operation of flood-control structures.
(g) The extent of operation of the model is determined each year by the testing programs requested by the Districts and Divisions that have operable sections on the model. Tests were conducted during the current year for the Missouri River Division, Ohio River Division, Lower Mississippi Valley Division, and the Southwestern Division. The tests consisted of studies of flood-routing methods to aid in flood forecasting and reservoir operations on the Missouri River, verification tests of the Kentucky reservoir and Tennessee River reservoir operation tests on the Cumberland River, hypothetical and project floods to aid in planning flood protection on the Mississippi River, and the development of stage and discharge data for ungaged tributary inflow points on the Arkansas River.

(425) COMPREHENSIVE MODEL STUDY, DELAWARE RIVER, PENNSYLVANIA.

(b) District Engineer, U. S. Army Engineer District, Philadelphia, Corps of Engineers, Philadelphia, Pa.
(d) Experimental; for design.

(e) To develop and test plans for reduction of shoaling in several ranges of the navigation channel, the entire Delaware River estuary from the Atlantic Ocean to Trenton is reproduced in the model which is of the fixed-bed, silt-injection type, with scale ratios of 1:1,000 horizontally and 1:100 vertically. Tides and tidal currents are reproduced by automatic tide-generators. Observed prototype salinities are reproduced in the Delaware Bay portion of the model, and provisions made for the injection of silt, and for measuring silt deposits. Studies are also made of salinity intrusion and the dispersion and dilution of wastes discharged into the estuary.
(g) Studies were made of effluent dispersion from several industrial plants located on the New Jersey shore. Results of these studies indicate that river discharge is the dominant factor controlling effluent concentration and upstream intrusion; outfall location may affect effluent concentrations along the shore in the vicinity of the plants, but will have little effect on concentrations throughout the river or on the extent of upstream intrusion. The results of tests of a deepened channel from Philadelphia to the sea are being analyzed, while results of tests of a complete or partial closure of Burlington Island back channel indicate that shoaling in the back channel would be materially reduced but that an opening through the fill would be required to prevent pollution of the remaining portion of the back channel.
(h) "DuPont Plant's Effluent Dispersion in Delaware River; Hydraulic Model Investigation", and "Dispersion of Effluent in Delaware River from New Jersey Zinc Co. Plant; Hydraulic Model Investigation." U. S. Army Engineer Waterways Experiment Station Miscellaneous Paper No. 2-222, May 1957, and Technical Report No. 2-457, June 1957, respectively (available on loan).

(673) GENERAL SPILLWAY MODEL TESTS.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A 1:40 model is being used to study hydraulic characteristics of the standard spillway shape with heads up to 1-1/3 times the design head of the crest, including the effect of crest piers and gates, elevation of downstream floor of spillway, and downstream slope of spillway. Tests will also be made to establish general rules for design of roller-type energy dissipators. The drop from spillway crest to bucket is varied to study the effect of nappe thickness. Tests to study pressures on a flat apron-type energy dissipator, to determine the effect of tainter gate location on spillway pressures and discharge characteristics,

and to study the effect on discharge coefficients of the location of the toe curve on a low ogee spillway have been completed.

(f) Suspended.

(674) MODEL STUDIES OF FORT RANDALL DAM, MISSOURI RIVER, SOUTH DAKOTA.

(b) District Engineer, U. S. Army Engineer Dist., Omaha, Corps of Engineers, Omaha, Nebraska.

(d) Experimental; for design.

(e) A 1:100 comprehensive model was used to determine effects on velocities of depth and curvature of the approach channel; to investigate flow over the chute-type, tainter-gate-controlled spillway, and develop a good stilling basin design; and to study flow conditions in the exit area. A 1:50 outlet stilling basin model was used: to develop a satisfactory stilling basin below the eight 28-foot-diameter conduits which were being used for diversion during construction and which will eventually be incorporated in the powerhouse substructure; to verify the design of the stilling basin for the four 22-foot-diameter flood-control conduits to insure satisfactory operation under present and future tailwater conditions; and to determine the limit of required tailrace paving and the necessity for bank protective works by study of currents and wave action. A 1:25 intake and flood-control conduit model was used to determine the character of flow for various reservoir levels; measure loss coefficients of the intake structure; investigate pressures in the transition section; and determine the effects of partial gate operation upon downpull and oscillation of the gates and upon air requirements.

(f) Testing completed.

(h) Final report in preparation.

(678) MODEL STUDY OF CHARLESTON HARBOR, SOUTH CAROLINA.

(b) District Engineer, U. S. Army Engineer District, Charleston, Corps of Engineers, Charleston, S. C.

(d) Experimental; for design.

(e) Tests were made to determine whether channel realinement, the provision of channel control works, or other remedial measures will be effective in reducing the present heavy rate of shoaling in certain reaches of the harbor navigation channels. The fixed-bed model had scales of 1:800 horizontally and 1:80 vertically.

(f) Testing completed.

(g) Tests show that diversion of 80% or more of fresh water discharge would reduce shoaling throughout harbor by 90%. Tests further show that channel realinement in conjunction with dikes at 3 shoals will reduce shoaling by 78% and will reduce total shoaling by 26%.

(993) CAVITATION RESEARCH.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) The purpose of the investigation is to study the cavitation characteristics of such structures as baffle piers, steps in stilling basins, and offset joints. The models are tested in a vacuum tank or a variable-pressure, closed-jet water tunnel. An investigation is being conducted to determine flow characteristics in gate slots with upstream and downstream seal gates. Flow from the lower lip of the upstream seal gate "expanded" into the slot and created severe turbulence and vortex action, indicating possible cavitation for prototype conditions. A review of literature is under way to evaluate the many variables that affect cavitation results.

(994) EFFECTS OF MODEL DISTORTION.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) A general study was made to determine the hydraulic effects of various types and degrees of model scale distortion on velocity distribution and other hydraulic conditions, with the ultimate aim of establishing limits of permissible distortion for the various types of models. Tests were conducted in a triangular flume having an adjustable central angle and adjustable slope; tests are in progress of a rectangular flume having a 90-degree bend with provisions for changing the vertical scale to provide a distortion of 0 to 10.

(g) Idalized triangular-flume studies were successful in establishing quantitatively the influence of channel shape on the channel resistance function for the cases studied. Continuation of studies of this type should be of value in the planning of model experiments and the interpretation of results, and should permit tabulation of parameters which would establish limits and effects of distortion for various types of models. However, much more extensive studies are required before such parameters can be determined. Because of economic factors the idealized studies have been discontinued in favor of a more direct and paractical approach.

(h) "Hydraulic Effects of Model Distortion: Report 1, Triangular-Flume Study of Distortion Effects", U. S. Army Engineer Waterways Experiment Station, Sept. 1957. (Available on loan.)

(998) STUDY OF WAVE FORCE ON BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) A general investigation of wave phenomena and resulting forces is to be conducted in a wave tank to develop formulas, supported by experimental data, from which

wave pressures on impervious surfaces, vertical and inclined, can be determined.

(999) STABILITY OF RUBBLE-MOUND BREAKWATERS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) Rubble-mound structures are studied in a wave tank to determine criteria for design and construction. Test data will be presented in dimensionless form; therefore no model scale is used.

(g) Test results on breakwaters constructed of shaped and sized cap rock (quarry stone) and protective layers of molded tetrapods and tetrahedrons indicate that the relationship between the more important variables is

$$W_r = \frac{\gamma_r H^3}{k_d (S_r - 1)^3 \cot \alpha}$$

where W_r is weight of individual armor units, γ_r is the specific weight of the armor unit, H is height of selected design wave, S_r is the specific gravity of armor units relative to the fluid in which the structure is located (γ_r/γ_w), α is the angle of the breakwater face, measured from the horizontal, and k_d is a dimensionless coefficient. For breakwaters constructed of armor stone, k_d varies from about 3 for the no-damage criterion to 16 when as much as 30-60 percent of the armor stone is removed from the design section by wave action. For breakwaters constructed with protective cover layers of tetrapods and tetrahedrons it was found that k_d was about 8 and 6, respectively, for no damage. Test results on breakwaters constructed of armor rock, tetrapods, and tetrahedrons have shown that wave run-up decreases with decreasing values of the angle between the face of the breakwater and the horizontal. Also, wave run-up decreases as wave steepness increases. The wave run-up factor (ratio between height of wave run-up and wave height) for rubble breakwaters varies from a maximum of about 1.1 for a 1-on-1-1/4 slope to a minimum of about 0.2 for a 1-on-5 slope. On tetrapod slopes, the maximum and minimum run-up factors are about 1.1 for a 1-on-1-1/3 slope and about 0.6 for a 1-on-3 slope. Preliminary analysis of wave run-up data on tetrahedron slopes indicates that the maximum and minimum run-up factors are about 1.1 for a 1-on-1-1/3 slope and 0.4 for a 1-on-3 slope.

(1000) ROUGHNESS STANDARDS FOR HYDRAULIC MODELS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) A general study was conducted to evaluate resistance of definite types of roughness in terms of Manning's "n" and other parameters, so that much of the trial-and-error process of adjusting the surface roughness of river models can be eliminated. Tests have been performed in three rectangular flumes and a triangular flume.

(f) Inactive.

(1002) SCALE EFFECTS IN HARBOR MODELS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) Tests are being conducted to determine more efficient procedures of operating wave action models and analyzing the results of wave studies. The program includes wave damping, model boundary effects, and the techniques of generating long-period waves.

(1004) INSTRUMENTATION.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; development.

(e) Various types of measurement and control equipment for use in hydraulic studies are being developed. These include equipment for measurement of velocity and direction of water flow, an acoustic flowmeter, equipment for generating model tides, measuring wave heights, and dynamic calibration of pressure cells.

(1207) MODEL STUDY OF PENSTOCK INTAKE AND SLUICE COASTER GATES.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) A general study of relative merits of various penstock intake and sluice coaster gate lip shapes, seals, and recesses is being conducted. The investigation includes determination of downpull effects of changes in gate lip shape, length and shape of seals, size and shape of the recess in the face of the dam, and need for an air vent in the entrance. The 1:20 model of the sluice coaster gate is being tested in combination with a typical sluice which includes a slide gate, standard entrance curves conforming to the elliptical equation

$$(x^2/D^2) + (y^2/(D/3)^2) = 1.$$

(1211) MODEL STUDIES OF HOOSIC RIVER, ADAMS AND NORTH ADAMS, MASSACHUSETTS.

(b) District Engineer, U. S. Army Engineer District, New York, Corps of Engineers, New York, New York.

(d) Experimental; for design.

(e) Three models were used to verify the hydraulic design for improvement of certain sections of the North and South Branches of Hoosic River in North Adams, Mass., and of the main channel in Adams, Mass.,

and to determine whether changes should be made for safety, increased efficiency, or economy. The flow in the major portion of these channels will be below critical depth. In Phase 1 of the North Adams study a 1:30 model reproduced the lower sections of the North and South Branches and about 1,300 feet of the main stream below the confluence of the North and South Branches. In Phase 2 North Branch was extended to include the control weir at the upstream limit of the improvement works for North Adams. In Phase 3 South Branch was extended upstream to include the debris basin at station 182+75. A 1:20 model reproduced a section of the main channel beginning in Adams approximately 8 miles above that reproduced in the 1:30 model. About 1,200 feet of Tophet Brook, which joins the Hoosic River, also was reproduced. The models were used to check such design features as channel alinement, transitions, superelevation in bends, characteristics of weirs, stilling basins, drop structures, the treatment of intakes and outlets, wall heights, and elevations of bridges.

(f) Inactive.

(h) "Flood Control Project, Hoosic River, Adams, Massachusetts: Report No. 2, Model Investigation of Phase II of Improvement Works", Waterways Experiment Station Technical Memorandum No. 2-339, Feb. 1957. (Available on loan.)

(1212) MODEL STUDIES OF OUTLET WORKS, OAHE DAM, MISSOURI RIVER, SOUTH DAKOTA.

(b) District Engineer, U. S. Army Engineer District, Omaha, Corps of Engineers, Omaha, Nebraska.

(d) Experimental; for design.

(e) Three models were constructed for complete investigation of the outlet works proposed for Oahe Dam. A 1:60 model, reproducing the downstream portion of six 18.25-foot-diameter outlet tunnels, the stilling basin, and 2,300 feet of the discharge and pilot channels, was used to investigate the performance of the outlet works and to effect revisions demonstrated to be desirable. A 1:25 model of the upstream portion of one of the flood-control tunnels, the control structure, and a short length of tunnel downstream was used to: (1) check piezometric pressures in the intake structure and transition, particularly pressure variations in the bulkhead slot area; (2) determine the effect of curvature on flow conditions in the upstream tunnel and critical areas downstream therefrom; (3) check piezometric pressures at various points in the gate chamber of the control shaft and the upstream and downstream transitions, with particular attention to pressures near the gate slots and (4) test surge conditions in the emergency gate well. A 1:25 model of one of the regulatory tunnels consisted of a short length of upstream tunnel, the control structure, and all of the downstream tunnel and was

used to: (1) check piezometric pressures in the gate slots, gate lip, transitions, and gate passage; (2) study the effects of forces acting on the service and emergency gates; (3) determine partial gate discharge ratings for the regulatory gate; (4) measure air demand characteristics; (5) determine flow characteristics in downstream transition and downstream tunnel for any condition of partial gate operation; (6) check piezometric pressures in the downstream tunnel; and (7) determine most suitable length of fillets required at outlet portal.

(f) Inactive.

(1467) ANALYSIS OF HYDRAULIC EXPERIMENTAL DATA (MODEL AND PROTOTYPE) AND DEVELOPMENT OF DESIGN CRITERIA.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Analytical (model and prototype) and field investigations; for design.

(e) A general study to develop, analyze, and disseminate to Corps of Engineers establishments, hydraulic design criteria to insure adequate capacity, economy of construction, and safe and satisfactory operation. Criteria are developed from model and prototype tests relating to the design of spillways, outlet works, gates and valves, channels, and navigation structures. Program also includes prototype tests in cooperation with other Corps of Engineers establishments.

(g) "Hydraulic design criteria" charts have been prepared on air entrainment in wide chute flow, low ogee spillway discharge coefficients, pressure drop coefficients for sluice entrances flared on four sides, intake losses for concrete conduits, discharge characteristics of gate valves, rock criteria for riprap and river closures. Design aid charts have also been prepared for gate vibration studies. Operating forces on prototype tainter valves were measured at Cheatham and McNary Locks. Vibrations of a submergible-type spillway tainter gate at Cheatham Dam and of a tainter valve and lock wall at McNary Dam were measured in the prototype. Piezometric pressures along prototype conduits and in their intakes were measured at Whitney and Denison Dams. Piezometric pressures and their rapid fluctuations in the vicinity of a prototype lock culvert tainter valve were recorded at McNary Lock.

(h) "Hydraulic Design Criteria" Issue No. 7. (Available for purchase in limited quantities.)

(1472) INDIANA HARBOR, INDIANA (LAKE MICHIGAN), MODEL STUDY OF WAVE ACTION.

(b) Youngstown Sheet and Tube Co. and Inland Steel Co., East Chicago, Indiana.

(d) Experimental; for design.

(e) Investigation of a proposed bulkhead was

conducted in a 1:150 fixed-bed-type model which reproduced all of Indiana Harbor. Sufficient area of adjacent shore line and hydrography lakeward of the harbor were reproduced to insure proper approach of waves from critical storm directions. Model waves were generated by a plunger-type wave machine 60 feet in length. Companion tests were performed in a small wave flume to determine the optimum design of a rubble wave absorber, using an undistorted scale of 1:50.

(f) Completed.

(1474) OPERATING FORCES OF MITER-TYPE LOCK GATES.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) A general study to collect basic data on operating forces of miter-type lock gates and to determine the effect of various elements upon these forces is being conducted in a 1:20 model. A lock chamber 110 feet wide is reproduced with provisions for varying the length up to 600 feet on each side of the gate. Forces required for operation of miter gates will be measured for variations of the following elements: gate leaves, speeds and accelerations of operation, submerged depths, recess shapes, bottom clearances, chamber lengths, and nonsynchronous operation of gate leaves. Variations in the type linkage driving the gate also will be investigated.
(f) Suspended.

(1475) SIPHON ACTION AT PUMPING PLANTS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) This study is being conducted to aid in developing design criteria for pumping plants that depend upon development of siphonic action in the discharge side of the pumps to yield the required discharge. A full-size model of a 6-inch plastic discharge line with a lift of 30 feet has provided data on the minimum initial priming velocity and length of time required to expel air from (prime) the siphon. Variables investigated during the tests were: rates of flow, water levels in the discharge side of the pumps, slopw and length of the riverward leg, and venting conditions at the crown. A full-size model of a 12-inch plastic discharge line has been constructed to aid in verifying design criteria.
(g) Analysis of test data has resulted in the following equation for the minimum velocity required to start siphonic action:

$$V_{min} = 0.457 \ \sqrt{gD} \ \left(\frac{L/D}{S}\right)^{0.121}$$

where V = velocity in full pipe in feet per second,
      D = diameter in feet,
      L = length of the sloping section

of the riverward leg,
      S = sine of angle with horizontal,
      g = acceleration due to gravity.
The generalized priming equation was derived from model data and checked against prototype siphons of various lengths, slopes, and diameters ranging from 12 to 72 inches. The observed velocities and priming times agreed very satisfactorily with the values computed by the generalized priming equation and the priming time curve obtained in the model tests. The following formula will give conservative size air vents at the summit (to reduce the positive phase of the priming cycle):

$$d = 0.25 \ D \left(\frac{2}{h}\right)^{0.25}$$

where d = diameter of air vent in feet,
      D = pipe diameter in feet,
      h = depth of submergence over the outlet in feet.

(1735) MODEL STUDY OF WAVE RUN-UP ON SHORE STRUCTURES.

(b) Resident Member, Beach Erosion Board, Corps of Engineers, Washington, D. C.
(d) Experimental; applied research.
(e) Tests were conducted in a wave flume, using a scale of 1:17, to investigate the relationship between water level, wave height, wave period, and beach slope and wave run-up on selected types of shore structures used to prevent erosion caused by wave action.
(f) Suspended.

(1736) MODEL STUDY OF EFFECTS OF INLETS ON ADJACENT BEACHES.

(b) Resident Member, Beach Erosion Board, Corps of Engineers, Washington, D. C.
(d) Experimental; applied research.
(e) To determine the effects of natural or artificial inlets on adjacent beaches for various conditions of waves, tides, rate of littoral drift, and other factors, tests are being made in a basin simulating an ocean and a lagoon separated by a barrier beach of sand that can be breached to reproduce the desired inlet.
(f) Inactive.
(h) Preliminary Report: "Laboratory Study of the Effect of an Uncontrolled Inlet on the Adjacent Beaches." Beach Erosion Board Technical Memorandum No. 94. (Copies available from the Beach Erosion Board.)

(1738) MODEL STUDIES OF GREENUP LOCKS AND DAM, OHIO RIVER.

(b) District Engineer, U. S. Army Engineer District, Huntington, Corps of Engineers, Huntington, West Virginia.
(d) Experimental; for design.
(e) A 1:120 model of the nonnavigable-type dam and twin parallel locks was used to

determine the best arrangements of locks and appurtenant walls, to study approach conditions under various flows and methods of operation of control gates, and to demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint. Additional tests were conducted to determine the feasibility of replacing portions of the upper and lower guard walls with pontons and cells. A 1:25 model reproduced the proposed emergency gate and a portion of the upper approach to the lock. The purpose of the model investigation was to determine the vertical forces acting on the 110-foot-wide by 11-foot-thick emergency gate as its crest is raised from elevation 497 to above the upper pool, elevation 515, under all possible conditions of tailwater.

(f) Testing completed.

(h) Final reports in preparation.

(1739) MODEL STUDIES OF MARKLAND LOCKS AND DAM, OHIO RIVER.

(b) District Engineers, U. S. Army Engineer Districts, Huntington and Louisville, Corps of Engineers, Huntington, W. Va., and Louisville, Kentucky.

(d) Experimental; for design.

(e) A comprehensive 1:120 model of the nonnavigable-type dam and twin parallel locks, a 1:36 section model of the spillway and stilling basin, a 1:4 section model of the gate sill and gate lip and two 1:25 models of a vertical-lift-type spillway gate and a submergible-type spillway tainter gate were constructed to: (1) Determine best arrangements of locks and appurtenant walls; (2) study approach conditions under various flows and methods of operation of control gates and powerhouse; (3) demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint; (4) investigate the design of the spillway and stilling basin elements; and (5) determine the hydraulic characteristics of a vertical-lift spillway gate and a submergible, tainter spillway gate.

(f) Testing completed; preparation of final report on section models in progress.

(g) Tests on the 1:120 model indicated that navigation conditions in the upper approach can be improved by straightening the alinement of the left bank upstream of the dam and dredging the right bank to reduce velocities in the upper approach. Additional ports will be required in the upper guard wall to reduce currents sweeping around the end of the wall. The top elevation of ports should be lowered to prevent tows from being drawn against the wall. The number of gate bays in the dam can be reduced from 13 to 12 without adversely affecting navigation. Any undesirable conditions in the lower approach resulting from operation of the powerhouse during low flows can be eliminated by operation of selected dam gates. Tests on the 1:36 model indicated the most satisfactory

stilling basin design to consist of a 74-foot-long basin with two rows of 6-foot-high baffle piers and a 4-foot-high end-sill. This model also showed that the vertical-lift gate of original design was satisfactory. The gate indicated no tendency to vibrate and maximum uplift and downpull forces on the gate were approximately 8 percent of the dry weight of the gate (653 kips). Tests on the 1:25 model of a submergible-type tainter gate also revealed satisfactory performance. Maximum downpull increased hoist loadings by about 50 percent while uplift forces were negligible. Vibration data indicated a maximum displacement of the gate of 0.225 inch at random frequencies ranging from 0.0 to 0.10 cycle per second.

(h) "Navigation Conditions at Markland Locks and Dam, Ohio River; Hydraulic Model Investigation." U. S. Army Engineer Waterways Experiment Station Technical Report No. 2-446, January 1957. (Available on loan.)

(1979) MODEL STUDY OF STILLING BASIN, BULL SHOALS DAM, WHITE RIVER, ARKANSAS.

(b) District Engineer, U. S. Army Engineer District, Little Rock, Corps of Engineers, Little Rock, Arkansas.

(d) Experimental; for design.

(e) The spillway was constructed with a stepped-type stilling basin designed to spread the jets issuing from the conduits. After a period of operation the steps were damaged by cavitation. A 1:12 model was used to develop a satisfactory method of repairing the basin for conduit discharges; a 1:50 section model was used to check the performance of the modified basin with spillway discharges.

(f) Testing completed.

(h) Final report in preparation.

(1980) MODEL STUDIES OF TABLE ROCK DAM, WHITE RIVER, MISSOURI.

(b) District Engineer, U. S. Army Engineer District, Little Rock, Corps of Engineers, Little Rock, Ark.

(d) Experimental; for design.

(e) A 1:50 section model of the stilling basin was used to determine the adequacy of the basin for spillway flow, and a 1:12 model of the stilling basin was used for tests of the basin under conduit flow. Current patterns and velocities around the training walls and in the powerhouse area were studied in a 1:100 general model.

(f) Testing completed.

(h) Final report in preparation.

(1982) MODEL STUDIES OF OLD RIVER LOW-SILL CONTROL STRUCTURE, OLD RIVER, LOUISIANA.

(b) President, Mississippi River Commission, Corps of Engineers, Vicksburg, Miss.

(d) Experimental; for design.

(e) The Old River low-sill control structure

will control flow into Old River, which links the Miss. and Atchafalaya Rivers, so that the Mississippi River flows will be divided between the lower reach of the Mississippi and Atchafalaya. Flow through the structure will be regulated by eleven, multiple-leaf, vertical-lift gates. Tests of 1:36 models were made to study the over-all performance of the structure with special attention to flow conditions at the abutments and the effectiveness of the stilling basin in dissipating energy under all tailwater conditions, and the adequacy of the downstream riprap placement plan. Because the possible range of headwater and tailwater elevations at the structure is extreme, studies were made on 1:36 and 1:60 models of the vertical-lift gates to determine the vertical forces that the gate leaves will be subjected to so that the suspension system and hoist machinery could be designed for maximum loading.

(f) Completed.
(g) Tests indicated that improved flow conditions could be obtained by realinement of the upstream and downstream training walls. It was demonstrated that the horizontal stilling basin could be raised from elevation -12.0 msl to elevation -5.0 msl, and that certain revisions to basin components produced improved stilling action. Down-pull tests of the vertical-lift gates showed that the two lower gate leaves should be operated together in order to eliminate destructive bouncing which occurred when the bottom leaf was operated by itself. The model riprap failed at a discharge slightly less than the maximum design flood and at a tailwater 5 feet deeper than the minimum predicted. Model tests failed to produce a riprap placement plan which was significantly better than the proposed design.
(h) "Old River Low-Sill Control Structure: Report 1, Downpull Forces on Vertical-Lift Gates; Hydraulic Model Investigation", and "Report 2, Studies of Riprap Placement Plans; Hydraulic Model Investigation." U. S. Army Engineer Waterways Experiment Station Technical Report No. 2-447, Dec. 1956 and July 1957, respectively. (Available on loan.)

(1983) MODEL STUDY OF SEDIMENT DIVERSION THROUGH OLD RIVER CONTROL STRUCTURES, LOUISIANA.

(b) President, Mississippi River Commission, Corps of Engineers, Vicksburg, Miss.
(d) Experimental; for design.
(e) A 10-mile reach of the Mississippi River upstream of the mouth of Old River was reproduced in fixed-bed and movable-bed models to scale ratios of 1:400 horizontally and 1:100 vertically. Tests were conducted on the fixed-bed model to determine a suitable location and design for control structures (consisting of an overbank and a low-sill structure) that will permit the same percentage of sediment to enter the Atchafalaya River as now enters that stream

through Old River, when Old River is closed with a lock and dam. Tests were then made on the movable-bed model to obtain indications of: (a) Future developments in the configuration of the Miss. River channel in the vicinity as a result of the diversion, and the effects of such developments on sediment distribution between the river and control structures; and (b) the effects of the diversion channel entrance shape and alinement on sediment diversion and scour of the channel banks.
(f) Completed.
(g) Principal conclusions were that the configuration of the portion of river channel reproduced would remain fairly stable if no diversion were made and that changes resulting from the diversion would be gradual under normal conditions. With the diversion normal to the river channel about 60 percent of the river sediment load would be diverted. Means of regulating the amount of sediment diverted and of protecting the diversion channel banks from scour were developed.
(h) "Old River Control Structure Sediment Diversion (second phase)." U. S. Army Engineer Waterways Experiment Station Technical Memorandum No. 2-388, Report 2, Oct. 1957. (Available on loan.)

(1984) MODEL STUDY OF CONTROL GATE FOR TUNNEL NO. 4, FORT PECK DAM, MISSOURI RIVER, MONTANA.

(b) District Engineer, U. S. Army Engineer District, Garrison, Corps of Engineers, Riverdale, North Dakota.
(d) Experimental; for design.
(e) Tests to study methods of eliminating cavitation on the port liner and vibration of the cylinder gate in the main control shaft of tunnel No. 4 were conducted on a 1:25 model. Discharge capacities, pressures, air demand, and gate vibration were determined for the existing cylinder gate installation.
(f) Testing completed.
(h) Final report in preparation.

(1985) DEVELOPMENT OF TURBULENCE METER.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.
(d) Experimental; development.
(e) The investigation is being conducted to develop instruments that will: (2) Indicate the speed and direction of fluid currents at both great and shallow depths and at both high and moderate velocities; (b) receive signals from (a) and separate them into (1) instantaneous velocity and direction, (2) mean velocity and direction, and (3) the root-mean-square deviations from the mean.
(f) A contract with the Iowa Institute of Hydraulic Research for delivery of a prototype instrument has been continued for additional refinement of the instrument.

(1986) SALT WATER INTRUSION AND RELATED PHENOMENA.

    (b) Committee on Tidal Hydraulics, Corps of Engineers (correspondence should be addressed to Mr. C. F. Wicker, Chairman, Committee on Tidal Hydraulics, U. S. Army Engineer District, Philadelphia, Corps of Engineers, Philadelphia, Pennsylvania).

    (d) Experimental; applied research.

    (e) To determine the effects of salinity and related phenomena on the vertical distribution of currents and shoaling characteristics in estuaries, tests are being made in a lucite flume 327 feet long, 1.5 feet deep, and 0.75 foot wide. One end of the flume is connected to a 25-foot-square tidal basin in which any desired tide may be produced and in which the salinity may be controlled. The opposite end is connected to a fresh-water source.

(1987) MODEL REPRODUCTION OF PROTOTYPE EROSION BELOW STILLING BASINS.

    (b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

    (d) Experimental; applied research.

    (e) Initially, the investigation will be conducted on a model of a selected dam with provisions for studying sands of different sizes in the channel below the stilling basin. Later, models with two or more different linear scales will be constructed to verify findings using suitable bed materials.

(1988) WATER TEMPERATURE EFFECTS ON BED FORMS AND ROUGHNESS.

    (b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

    (d) Experimental; applied research.

    (e) A laboratory flume, in which water temperatures can be varied to simulate normally experienced summer and winter temperatures, is being constructed for investigating the effects of water temperature on bed forms and bed roughness of various types of bed materials.

(2201) MODEL STUDY OF LAKE REGULATION, LAKE ERIE.

    (b) District Engineer, U S. Army Engineer District, Buffalo, Corps of Engineers, Buffalo, N. Y.

    (d) Experimental; for design.

    (e) An existing model of Niagara River and Falls was used to determine the nature and extent of excavation in Niagara River that would be required to increase the outlet capacity of the river at high lake levels. The design of a regulatory structure that would control flow into the river during low lake levels was also investigated. The fixed-bed model, constructed to scales of 1:360 horizontally and 1:60 vertically, reproduced 26 miles of the Niagara River from Lake Erie to the Falls.

    (f) Completed.

    (g) Two excavation plans were investigated:

one based on a wide, shallow channel and the other on a deep, narrow channel. Test results indicated that either plan would produce substantial lowering of lake levels through excavation of up to about 10,000,000 cubic yards; greater amounts of excavation would produce only slight additional lowerings. Of the two plans, the deep, narrow design was found more efficient.

Two locations of the regulatory structure were studied; one about 4,000 feet upstream from Peace Bridge, and the other about 700 feet downstream from the bridge. At each location tests were made of the structure closing from both the American and Canadian sides. Test results showed that at the above-bridge location a shorter length of the structure could be closed on the American side than on the Canadian side and the desired regulation achieved; downstream from Peace Bridge the reverse was true.

    (h) "Plans for Regulation of Levels of Lake Erie; Hydraulic Model Investigation." U. S. Army Engineer Waterways Experiment Station Technical Report No. 2-456, June 1957. (Available on loan.)

(2203) MODEL STUDY OF WAVE RUN-UP AND OVERTOPPING, LAKE OKEECHOBEE LEVEE SECTIONS, FLORIDA.

    (b) District Engineer, U. S. Army Engineer District, Jacksonville, Corps of Engineers, Jacksonville, Florida.

    (d) Experimental; applied research and design.

    (e) A model investigation of levee sections proposed for impounding Lake Okeechobee was conducted to determine the effectiveness of different types of sections in preventing excessive overtopping of the protective levees by hurricane-generated waves. Most of the tests were conducted on 1:30-scale models of the levee sections installed in a wave flume 94 feet long with a testing section 1.5 feet deep and 1 foot wide. A few tests were conducted in a larger wave flume (119 feet long, 4 feet deep, and 5 feet wide) using a linear scale of 1:17, model to prototype. The height of wave run-up on and volume of water overtopping levee sections of various slopes, crown elevations, and lakeside berms for several depths of water at beach toe and levee toe were determined. Based on model test data, a method for selecting optimum designs for the different reaches of levee at Lake Okeechobee was developed.

    (f) Completed.

    (g) Test results showed that the height of wave run-up and quantities of overtopping water vary with wave height, wave period, levee slope, shape of levee face, depth of water at toe of levee slope, and depth of water at break in grade of composite levee slopes. The height of wave run-up and quantity of overtopping water decrease as the slope of the levee decreases

and increase as the wave height and wave period increase. The construction of berms on the lakeside of the levee face and a decrease in water depth at the toe of the levee slope decrease the height of wave run-up. An increase in the model scale results in a small increase in wave run-up and an increase in overtopping which increases as the quantity of overtopping decreases. Although there is evidence of scale effect, the model data are believed to be sufficiently accurate for selection of an efficient levee section. Test results showed that, excluding levee slopes of 1 on 2 and 1 on 10, which are considered impractical, a levee slope of 1 on 6 would be very efficient.

(h) "Wave Run-up and Overtopping Levee Sections, Lake Okeechobee, Florida; Hydraulic Model Investigation." Waterways Experiment Station Technical Report No. 2-449, January 1957. (Available on loan.)

(2426) MODEL STUDY OF NAVIGATION LOCK, PORT ALLEN, LOUISIANA.

(b) President, Mississippi River Commission, Corps of Engineers, Vicksburg, Miss.
(d) Experimental; for design.
(e) A new channel in the Gulf Intracoastal Waterway from Indian Village to Port Allen, Louisiana, includes a navigation lock in the Mississippi River levee at that point. Several designs for the lock ports were tested in a preliminary culvert and single port model constructed to a 1:25-scale ratio. The major investigations were conducted in a 1:25 model reproducing 150 feet of upstream approach, intake manifolds, 1,250 feet of lock chamber, culverts, lateral ports, outlet manifolds, and 1,000 feet of downstream topography.
(f) Final report in preparation.
(g) Satisfactory designs were developed for the ports and intake and outlet manifolds. Valve schedules for filling and emptying operations were developed.

(2427) MODEL STUDY OF OUTLET WORKS, ABIQUIU DAM, RIO CHAMA, NEW MEXICO.

(b) District Engineer, U. S. Army Engineer District, Albuquerque, Corps of Engineers, Albuquerque, New Mexico.
(d) Experimental; for design.
(e) A 1:20 model reproduced the 12-foot-diameter outlet tunnel including the control section consisting of twin gate passages and a flip-bucket energy dissipator. Of particular interest were the transitions between the rectangular gate passages and the circular tunnel.
(f) Testing completed.
(g) A satisfactory gate transition section and a junction for the controlled and uncontrolled outlets were developed. Also a flip-bucket design was developed that gives reasonable distribution of flow in the exit area.
(h) Final report in preparation.

(2428) MODEL STUDY OF SAVANNAH HARBOR, GEORGIA.

(b) District Engineer, U. S. Army Engineer District, Savannah, Corps of Engineers, Savannah, Georgia.
(d) Experimental; for design.
(e) The investigation is being conducted in a model which reproduces the following: (a) that portion of the Atlantic Ocean, adjacent to the harbor entrance, from Caliboque Sound on the north to Wassaw Sound on the south; (b) the Savannah River and its flood plain to the head of tide at Ebenezer Landing; and (c) that portion of the Intracoastal Waterway which crosses the area included in the model. The model is of fixed-bed construction with scale ratios, model to prototype, of 1:800 horizontally and 1:80 vertically. Automatic tide generators are used to reproduce tides and tidal currents throughout the harbor, and salt water is used in the model ocean to reproduce the effects of density difference on current velocities and distributions. Shoaling studies are made by injecting finely ground gilsonite into the model to reproduce the patterns of shoaling as observed in the prototype, following which the effects of proposed improvement plans on shoaling patterns may be observed and evaluated. Studies are also made of the effects of proposed improvement plans on dispersion and dilution of contaminants discharged into the harbor.
(g) Tests of plans designed to reduce shoaling in the harbor, or to shift the location of major shoals to areas where dredged spoil disposal can be accomplished without difficulty, indicate that diversion of fresh water would greatly reduce shoaling, and off-channel sediment traps would be effective in localizing shoaling, thus reducing maintenance dredging costs.

(2429) MODEL STUDIES OF THE CORNWALL ISLAND AND BARNHART ISLAND - LAKE ST. FRANCIS REACHES, ST. LAWRENCE RIVER.

(b) District Engineer, U. S. Army Engineer District, Buffalo, Corps of Engineers, Buffalo, N. Y.
(d) Experimental; for design.
(e) Two fixed-bed models are being used to study plans for navigation improvement in the lower portion of the International Rapids section of the St. Lawrence River. A 1:100 model of the Cornwall Island Reach reproduces all features of the river from just below the tailrace of the proposed Barnhart Island powerhouse to about the mid-point of Cornwall Island, and includes portions of both the north and south Cornwall Island channels, Polly's Gut, and the entrance to Grass River locks. A model of the Barnhart Island-Lake St. Francis Reach, built to scales of 1:300 horizontally and 1:100 vertically, reproduces a greater area upstream and downstream of Cornwall

Island. Both models are being used to study navigation conditions in the approach to the Grass River locks, proposed plans for excavations in both Cornwall Island channels to effect navigation improvement in South Channel, and to determine conditions that will be encountered by navigation during the construction of the project features in the Cornwall Island Reach.

(2430) GARY HARBOR, INDIANA (LAKE MICHIGAN), MODEL STUDY OF WAVE ACTION.

(b) U. S. Steel Corporation, Gary Steel Works, Gary, Indiana.
(d) Experimental; for design.
(e) Investigation of a proposed bulkhead was conducted in a 1:150 fixed-bed-type model which reproduced Gary Harbor. Sufficient area of adjacent shore line and hydrography lakeward of the harbor was reproduced to insure proper approach of waves from various storm directions. Model waves were generated by a movable plunger-type wave machine 40 feet in length. Tests were conducted in a small wave flume to determine the optimum design of a wave absorber to reduce wave reflection from the proposed bulkhead, using a 1:50 scale in the flume tests.
(f) Completed.

(2431) MODEL STUDIES OF STILLING BASIN, WARRIOR DAM, WARRIOR RIVER, ALABAMA.

(b) District Engineer, U. S. Army Engineer District, Mobile, Corps of Engineers, Mobile, Alabama.
(d) Experimental; for design.
(e) Two section models were used to determine a stable slope for dumped riprap immediately downstream from the stilling basin and to verify the adequacy of the spillway and stilling basin designs for this proposed navigation structure: (a) A 1:20 model reproducing 400 feet of the approach area, a portion of the spillway crest, left embankment, and stilling basin (2 full gate bays and adjacent half bays), and 800 feet of the exit area; and (b) a 1:60 model of the center section of the spillway and stilling basin reproducing one full gate bay and adjacent half bays.
(f) Testing completed.
(g) Satisfactory design of spillway and stilling basin, method of spillway gate operation, and determination of a stable slope for dumped riprap below the stilling basin were accomplished.
(h) Final report in preparation.

(2432) MODEL STUDIES OF FORT GAINES LOCK AND DAM, CHATTAHOOCHEE RIVER, GEORGIA.

(b) District Engineer, U. S. Army Engineer District, Mobile, Corps of Engineers, Mobile, Alabama.
(d) Experimental; for design.
(e) Two models were used to study the hydraulic characteristics of the spillway and

stilling basin, orientation of spillway and powerhouse in the river channel, and the alinement and location of the lock for this proposed navigation structure: (a) A 1:80 model reproducing the entire problem area, including 1,500 feet of the approach area, the spillway, and navigation lock, and 3,500 feet of the exit area; and (b) a 1:40 model of the center section of the spillway and stilling basin reproducing one full gate bay and adjacent half bays.
(f) Testing completed.

(2434) MODEL STUDY OF VERMILLION BAY, LOUISIANA.

(b) Department of Public Works, State of Louisiana.
(d) Experimental; for design.
(e) Vermilion Bay, on the Louisiana coast, is connected with the Gulf of Mexico through the deep and narrow channel of Southwest Pass, and is part of a bay system consisting of East Cote Blanche, West Cote Blanche, and Atchafalaya Bays. The Vermilion River and several smaller streams flow into Vermilion Bay, but their combined discharges are too small during the summer to prevent intrusion of saline Gulf waters into the bay through Southwest Pass. On the other hand, because of barrier reefs and the discharge of the Atchafalaya River, the waters of East Cote Blanche, West Cote Blanche, and Atchafalaya Bays are fresh enough for irrigation purposes during most of the year. The plan of improvement contemplates closure of Southwest Pass in an attempt to bring the salinity of Vermilion Bay into agreement with that of these other bays. Should this plan not be effective, the shallow entrances to the other bays might also be closed, provisions being made to pass the discharge of the tributary streams over the closures. A fixed-bed model, to linear scales of 1:100 vertically and 1:2,000 horizontally, reproduces a part of the Gulf of Mexico, Vermilion, East Cote Blanche, West Cote Blanche, and Atchafalaya Bays, and portions of the tributary streams. Provisions were included for reproducing salt water, as well as fresh water, flow.
(f) Testing completed.

(2673) MODEL STUDY OF BARKLEY DAM, CUMBERLAND RIVER, TENNESSEE.

(b) District Engineer, U. S. Army Engineer District, Nashville, Corps of Engineers, Nashville, Tennessee.
(d) Experimental; for design.
(e) A 1:120 model, reproducing the Cumberland River from mile 29.4 to 32.2, the lock, dam, and powerhouse, is being used to investigate flow characteristics in the approaches to the lock. A 1:36 model, reproducing the riverward downstream lock wall including the culvert manifold which discharges into the spillway stilling

basin, a discharge manifold discharging through the stilling basin, five spillway bays, 324 feet of approach channel, and 596 feet of exit channel, is being used to investigate flow characteristics in the stilling basin and exit channel.

(g) Flow conditions were observed and water-surface profiles and velocities measured throughout the models.

(2674) MODEL STUDY OF CALUMET RIVER LOCK, SOUTH CHICAGO, ILLINOIS.

(b) District Engineer, U. S. Army Engineer District, Chicago, Corps of Engineers, Chicago, Ill.

(d) Experimental; for design.

(e) The Calumet River Lock in South Chicago will be part of a project for widening and deepening the Calumet-Sag Channel, an important link in the Great-Lakes-to-the-Gulf Waterway. The lock will be 1,000 feet long, 110 feet wide, and will provide a depth of 12 feet over the sills. Normal lifts will be of the order of 5 feet; however, extreme conditions can produce head differentials as great as 9 feet. Also, normal operation will require lifts from the navigation pool to lake elevation but reversal in head during periods of low lake level is possible. Filling and emptying of the lock will be accomplished between the leaves of sector gates, supplemented by loop culverts around the lakeside sector gates. Filling and emptying characteristics were studied on a 1:20 model which reproduced the immediate approaches and entire lock. Provisions were made for mechanical operation of the sector gates and automatic recording of pertinent data.

(f) Final report in preparation.

(2675) MODEL STUDIES OF DARDANELLE DAM, DARDANELLE, ARKANSAS.

(b) District Engineer, U. S. Army Engineer District, Little Rock, Corps of Engineers, Little Rock, Arkansas.

(d) Experimental; for design.

(e) Two models are being used for the investigation. A 1:120 model reproduces the structures and 4,000 feet of approach channel and 8,000 feet of exit channel. The approach channel is molded in concrete to overburden contours while the exit channel is molded in concrete to bedrock contours but has the overburden topography molded in pea gravel in order to facilitate revision of the channel configuration. It is proposed to measure currents around the lock approaches for all arrangements of structures; measure forces against barge tows in the lock approaches; and introduce some type of lightweight material into the model to reveal sedimentation tendencies. A 1:50 section model reproducing one full and two adjacent half-bays of the spillway and stilling basin is being utilized for studies of the adequacy of the weir and stilling basin design. This model has a

glass side so that flow patterns can be observed directly.

(2676) HIGH VELOCITY PITOT TUBE.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; development.

(e) A cantilevered strut is being developed for holding a pitot tube in open channel flows with maximum depths of 5 feet and maximum velocities of 60 feet per second.

(g) The submergible part of the strut has been fabricated from 2-1/2-inch-diameter, high strength tool steel. The traversing mechanism for a 14-1/2-foot-wide channel will be manufactured upon completion of design by the U. S. Army Engineer District, Los Angeles.

(2677) MODEL STUDY OF KALAMAZOO RIVER, BATTLE CREEK, MICHIGAN.

(b) District Engineer, U. S. Army Engineer District, Detroit, Corps of Engineers, Detroit, Mich.

(d) Experimental; for design.

(e) The project includes enlargement of portions of Battle Creek and Kalamazoo River, which join within the city of Battle Creek, and construction of a cutoff channel to carry Kalamazoo River flow through part of the city to the confluence. A 1:40 model was used to study flow conditions at Fountain Street bridge over the cutoff and at the confluence, and to determine necessity for superelevation of channel curves.

(f) Completed.

(g) Channel realinement at the bridge and addition of sharp-nosed extensions to the upstream bridge piers improved flow. At the confluence satisfactory flow conditions were produced by a longer curve on one wall and an extension into the river of the other wall. Superelevation of channel curves was found unnecessary. Tests were also made to determine if abutments of two railroad bridges could be permitted to encroach on the cutoff channel to shorten the bridge spans, but this was found undesirable.

(h) "Flood-Control Project for Kalamazoo River at Battle Creek, Michigan." U. S. Army Engineer Waterways Experiment Station Technical Report No. 2-465, Oct. 1957. (Available on loan.)

(2678) MODEL STUDY OF LOCKS AND DAM NO. 41, LOUISVILLE, KENTUCKY.

(b) District Engineer, U. S. Army Engineer District, Louisville, Corps of Engineers, Louisville, Kentucky.

(d) Experimental; for design.

(e) A fixed-bed, 1:120 model reproduces a four-mile reach of the Ohio River including adjacent overbank areas, the locks and dam structures, and all bridges and other structures that might affect flow

conditions. Investigations are being made to: Determine the effects of location, size, and alinement of a new approach channel on navigation and surge conditions; determine the best location for a new navigable span on the Pennsylvania Railroad bridge; determine a method of operating the dam for optimum navigation conditions; study navigation conditions in the lower approach as affected by flow through dam, powerhouse, and lock-emptying system; and provide a means for navigation interests to satisfy themselves as to the acceptability of the proposed plan by observing the model in operation.

(g) Tests indicate that enlarging the existing canal would provide better entrance conditions. Navigation conditions were satisfactory in the lower approach for the flows tested.

(2679) MODEL STUDY OF PANEL GATES, OLD RIVER OVERBANK STRUCTURE.

(b) President, Mississippi River Commission, Corps of Engineers, Vicksburg, Miss.
(d) Experimental; for design.
(e) The Old River overbank structure will help to control diversion from the Mississippi River to the Atchafalaya River during flood stages. The structure will consist of a low weir with crest elevation of 52.0 msl surmounted by piers and panel gates for controlling discharge. The spillway will contain 73 gate bays with clear widths of 44 feet. Each bay will be fitted with 15 panels measuring 2 feet 10-1/2 inches by 18 feet. The panels will be hinged to the superstructure above the weir and will seal against the weir at the lower ends. The gates will be operated by a crane cable attached to the lower ends of the panels. A 1:8 section model of the spillway and stilling basin, reproducing one full bay and about 36 percent of each of the two adjacent bays, was used for the study.
(f) Testing completed.
(h) Final report in preparation.

(2680) MODEL STUDY OF HURRICANE TIDES IN NARRAGANSETT BAY, RHODE ISLAND.

(b) Division Engineer, U.S. Army Engineer Div., New England, Corps of Engrs., Boston, Mass.
(d) ·Experimental; for design.
(e) A fixed-bed model, 1:1,000 horizontally and 1:100 vertically, reproduces all of Narragansett Bay and an adjacent portion of the Atlantic Ocean. An automatic tide generator reproduces normal tides throughout the model, and a separate, manually operated generator reproduces hurricane tides of the desired characteristics at the bay entrance. Numerous barrier plans for prevention of hurricane-tide damage have been proposed. The relative and absolute effectiveness of these plans in reducing hurricane-tide elevations throughout the bay system were determined and the effects of the best plan on such important factors as tidal

circulation, pollution, salinity, and shoaling for normal conditions are under investigation. Fresh water only was used in the model during tests of the proposed barrier plans, but both salt and fresh water are being used in the tests to determine the effects of the best barrier plan on all significant factors for normal conditions. Model appurtenances consist of automatic tide gages to record both hurricane-tide and normal-tide elevations at critical points, recording salinity meters, recording dye meters for observing pollution and/or flushing characteristics, current velocity meters, and equipment for simulating shoaling of the channels and other navigation facilities.

(g) Tests of 36 plans for reduction of hurricane-tide heights in the bay area indicated that the most satisfactory plan consisted of a barrier in the upper bay near Fox Point and barriers in the lower bay near the Jamestown Bridge in West Passage, Bull Point in East Passage, and Tiverton in the Sakonnet River. All of the lower bay barriers include fixed openings for navigation. The results of supplementary tests to determine the effects of these structures on salinity, pollution, and shoaling are being analyzed.
(h) "Protection of Narragansett Bay From Hurricane Tides." Interim Report, Feb. 1957. (Available on loan.)

(2681) LARGE SCALE TESTS OF RUBBLE-MOUND BREAKWATERS.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.
(d) Experimental; applied research.
(e) Tests are to be conducted by the Beach Erosion Board, under the general supervision of the Waterways Experiment Station, to investigate the effects of model scale on the results of experimentally determined criteria for the design of rubble-mound breakwaters. Stability tests will be conducted on breakwater slopes of 1 on 1-1/2 and 1 on 2-1/2, using wave periods of 3.36, 5.60, and 7.87 seconds. Tests in the Beach Erosion Board wave flume (15 feet by 20 feet by 635 feet) are being conducted using a linear scale of 7.5 to 1 based on the tests conducted in the Waterways Experiment Station 5- by 4- by 119-foot wave flume. Stability tests have been conducted in the Waterways Experiment Station small wave flume (1 foot by 1.5 feet by 94 feet) using a scale of 0.5 to 1 based on tests conducted in the 5- by 4- by 119-foot wave flume. Therefore, data on the stability of rubble-mound breakwaters will be available for three different linear scales, 0.5 to 1, 1 to 1, and 7.5 to 1.

(2682) SACRAMENTO BARGE CANAL LOCK MODEL STUDIES, SACRAMENTO RIVER, CALIFORNIA.

(b) District Engineer, U.S. Army Engineer

District, Sacramento, Corps of Engineers, Sacramento, Calif.

(d) Experimental; for design.

(e) The Sacramento Barge Canal Lock on the Sacramento River is part of the proposed improvement for the Sacramento River Deep Water Ship Canal. The project plan consists of (a) a deep water channel from Suisan Bay to Washington Lake, 30 feet deep at mean low water, 200 feet wide in tangents and 300 feet wide in curves and through existing channels,(b) a 70-acre, 30-foot-deep harbor at Lake Washington, (c) a connecting barge canal from Washington Lake to Sacramento River, 13 feet deep and 120 feet wide with a navigation lock 86 by 600 feet, and a combination highway and railroad bascule bridge. The maximum anticipated lock lift determined from a study of proposed flow conditions is 21.1 feet. A minimum depth of 13 feet is provided over the upper and lower gate sills. Because of the possibility of a reversal of head, sector gates were selected as the means of filling and emptying the lock. Flow will pass directly into or from the lock between the gate leaves as they are opened. In addition the gate leaves and recesses have been designed so that flow will pass between the face of the leaves and the wall of the recesses, thereby providing three flow passages at each end of the lock. The immediate approaches and entire lock were reproduced in a 1:20 model. Provisions were made for mechanical operation of the sector gates and automatic recording of pertinent data.

(f) Completed.

(g) Operating schedules have been developed for lifts through 21 feet with hawser stresses not exceeding 5 tons.

(h) Final report in preparation.

(2683) MODEL STUDY OF SURGES, LONG SAULT CANAL, ST. LAWRENCE RIVER.

(b) District Engineer, U. S. Army Engineer, District, Buffalo, Corps of Engineers, Buffalo, N. Y.

(d) Experimental; for design.

(e) Surges in the intermediate pool produced by failure of the upstream lock (Eisenhower Lock) gates were studied in a fixed-bed model built to linear scale ratios of 1:200 horizontally and 1:100 vertically. The model reproduced all pertinent features of the portion of Long Sault Canal extending from just upstream of Eisenhower Lock to the downstream end of the Grass River Lock. Included in the model were Eisenhower and Grass River Locks, Dike No. 6, and the 18,000-foot-long intermediate pool.

(f) Testing completed.

(2684) SUPERELEVATED FLOW INVESTIGATIONS.

(b) Office of the Chief of Engineers, Department of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) This study will be an extension of the work performed by the U. S. Army Engineer District, Los Angeles, CE, involving model study of superelevated flow in curved open channels. It will be concerned with the use of superelevated spirals in simple and S-curves of very short radii. A second phase of the study will be concerned with design of curves for equal distribution of energy across the channel at the downstream end of the curve.

(2685) MODEL STUDY OF WAVE ACTION, SUPERIOR ENTRY, DULUTH-SUPERIOR HARBOR, LAKE SUPERIOR.

(b) District Engineer, U. S. Army Engineer District, St. Paul, Corps of Engineers, St. Paul, Minn.

(d) Experimental; for design.

(e) A 1:150 fixed-bed model reproduces all the navigation approach channel and harbor breakwater structures as well as the inner harbor dock area serving Superior, Wis. The model consists of adjacent lake and shore-line areas to permit reproduction of storm waves from all critical directions. Investigations are being made: To determine the reasons for the wind-wave problems that exist and cause ship damage in the vicinity of the Superior Entry; and to develop the most effective remedy possible so that navigation and docking hazards now prevailing will be adequately reduced.

(g) Results of a wave-refraction study indicate that storms from N 54°E and N 62°30'E are critical for this harbor. Tests performed to date show that severe wave action now obtains along the Great Northern Railway ore docks during storms from these directions. A detached breakwater about 1,500 feet long will provide adequate protection to the inner harbor if the navigation aspects are judged satisfactory.

(2686) MODEL STUDY OF WOONSOCKET FALLS DAM, BLACKSTONE RIVER, RHODE ISLAND.

(b) Division Engineer, U. S. Army Engineer Division, New England, Corps of Engineers, Boston, Mass.

(d) Experimental; for design.

(e) A 1:50 fixed-bed model reproduced the Blackstone River from about 1,600 feet above to about 600 feet below the dam, and included provisions for measuring pressures on the downstream side of the dam. The flood-control project channel improvement includes reconstruction of the dam and rock excavation between the toe of the dam and a bridge just downstream to minimize submergence of the dam.

(f) Testing completed.

(h) Final report in preparation.

(2925) ULTRASONIC FLOW MEASUREMENT.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.

(d) Experimental; for design
(e) Various types of ultrasonic equipment will be investigated in a 12-inch by 8-inch conduit, with full and partial flow, to determine the relative accuracy of each type.

(2926) FLOOD-CONTROL MODEL, LOWER MISSISSIPPI RIVER.

(b) President, Mississippi River Commission, Corps of Engineers, Vicksburg, Miss.
(d) Experimental; for design.
(e) The Mississippi River flood-control model is of the fixed-bed type with a horizontal scale of 1:2,000 and a vertical scale of 1:100, and reproduces the Mississippi River from Helena, Arkansas, to Donaldsonville, Louisiana, the Arkansas-White, Yazoo, and Red-Ouachita backwater areas, the Old River Channel from Angola to Barbre Landing, Louisiana, the Atchafalaya River and Basin to the Gulf of Mexico, and the Morganza and West Atchafalaya Floodways. A series of tests was conducted to obtain stage and discharge data on past floods of record, adjusted to 1950 prototype conditions, with the proposed Yazoo River backwater levee in place. Another series of tests, concerned with the Atchafalaya River basin, was conducted to determine the effects of side channel closures and dredging on stages in the main channel within the Atchafalaya basin and to obtain data for the development of future dredging programs.

(2927) MODEL STUDY OF NAVIGATION CONDITIONS, TROY LOCK AND DAM, HUDSON RIVER, NEW YORK.

(b) District Engineer, U. S. Army Engineer District, New York, Corps of Engineers, New York, New York.
(d) Experimental; for design.
(e) Navigation conditions at Troy Lock are adversely affected by the facts that the lock and dam are the upper limit of tidewater in Hudson River, and a branch of the Mohawk River enters the Hudson in an upstream direction just above the lock. Tests to determine the most effective and economical plan for eliminating the hazardous navigation conditions at the upper entrance to the lock are being conducted in a 1:100 model of the pertinent reach of the Hudson and the lower 1,800 feet of the Mohawk branch. The model includes the lock and dam, all bridge piers within the model limits, and sufficient overbank area to reproduce flood flows. A remote-controlled towboat with tow is used to determine the effect of currents on tows entering and leaving the locks.
(g) Tests indicate that the navigation problem is due principally to the positions of lock and upper guard wall, which are not in line with the project channel and main currents, and to the limited maneuver area available for tows attempting to overcome effects of adverse currents rather than to the Mohawk River branch flow.

(2928) MODEL STUDY OF LOWER REACHES, ARKANSAS RIVER NAVIGATION PROJECT.

(b) District Engineer, U. S. Army Engineer District, Vicksburg, Corps of Engineers, Vicksburg, Mississippi.
(d) Experimental; for design.
(e) Several alternate routes have been proposed for the lower 54 miles of the navigation project between Pine Bluff, Ark., and the Mississippi River. A fixed-bed model with scales of 1:600 horizontally and 1:100 vertically, and reproducing pertinent portions of the Mississippi River channel, the White River channel, and the Arkansas River channel, and adjacent overbank areas, will be used to determine the effects of stage fluctuations, overbank flow, channel alinements, and other hydraulic features on the proposed routes for the lower reaches of the navigation channel and on the location and alinement of the entrance from the Mississippi River. The investigation will also serve to determine the necessity for special studies in connection with the project.

(2929) MODEL STUDY OF NEW RICHMOND LOCKS AND DAM, OHIO RIVER.

(b) District Engineer, U. S. Army Engineer District, Huntington, Corps of Engineers, Huntington, West Virginia.
(d) Experimental; for design.
(e) A 1:120 model reproducing three miles of the Ohio River and the main and auxiliary locks together with the dam structures is being used to: Determine the best arrangement of the locks and appurtenant walls; study approach conditions under various river flows and methods of operation of dam control gates; develop modifications required to overcome any undesirable conditions; and demonstrate to navigation interests the acceptability of the proposed design from a navigation standpoint.
(g) Results indicate that there should be no serious navigation difficulties in the entrances to the upper and lower approaches to the locks. It was recommended that the elevation of the top of ports be lowered to reduce the tendency for tows to be pulled towards the upper guard wall.

(2930) MODEL STUDIES OF SPILLWAY AND STILLING BASIN, AND NAVIGATION CONDITIONS, JACKSON LOCK AND DAM, TOMBIGBEE RIVER, ALABAMA.

(b) District Engineer, U. S. Army Engineer District, Mobile, Corps of Engineers, Mobile, Alabama.
(d) Experimental; for design.
(e) Three models are being used to develop profiles and capacities of a fixed-crest and a gated spillway, dimensions of the stilling basins below each, and to study currents and velocities in the lock approaches. A 1:36 model of a section of the approach area, fixed-crest spillway, stilling basin, and exit area, and a 1:50 model

of a like section of the gated spillway are being tested. Navigation conditions at the locks are being investigated in a 1:120 model of a 1.5-mile reach of the river including the lock and dam and approach channels. The effects of currents and velocities on tows entering or leaving the lock are observed, and modifications in lock or channel configurations are tested to modify any undesirable conditions noted.

(2931) MODEL STUDY OF SOUTHWEST PASS, MISSISSIPPI RIVER.

(b) District Engineer, U. S. Army Engineer District, New Orleans, Corps of Engineers, New Orleans, Louisiana.

(d) Experimental; for design.

(e) To determine the effectiveness of proposed improvement works (jetty extensions, channel realinements, and contraction works) in eliminating or reducing the periodic maintenance now required in order for deep-draft vessels to navigate the jetty and bar channels of Southwest Pass, the lower 12 miles of the Pass and the adjacent area of the Gulf of Mexico will be reproduced in a movable-bed model to scale ratios of 1:500 horizontally and 1:100 vertically. Tides, tidal currents, littoral currents, and wave action in the Gulf of Mexico, and salt- and fresh-water flows in Southwest Pass and the bar channel will be simulated. Model reproduction of existing hydraulic, salinity, and shoaling conditions will first be verified; then plans for reducing maintenance dredging will be tested.

(2932) MODEL STUDY OF HUDSON RIVER, NEW YORK.

(b) District Engineer, U. S. Army Engineer District, New York, Corps of Engineers, New York, New York.

(d) Experimental; for design.

(e) A fixed-bed model study, built to scales of 1:100 vertically and 1:1,000 horizontally, is to be used to determine the source of material shoaling the Hudson River in the vicinity of Edgewater and Weehawken piers and the most effective means of reducing or eliminating this shoaling. The model reproduces Upper and Lower New York Bays, Raritan Bay, Hudson River to Hyde Park, East River to Throg's Neck, and tributaries flowing into the modeled bodies of water. Provisions are made to reproduce tides, fresh-water discharge, salinity intrusion, and shoaling.

(2933) STUDY OF HARBOR DESIGN.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) A testing program is being prepared to determine general criteria for designing harbors and harbor works to obtain optimum protection from wave action. Program will include both wind waves and seiches, and wave refraction and diffraction as applied

to harbor and breakwater planning will be investigated.

(2934) DESIGN OF RUBBLE WAVE ABSORBERS.

(b) Office of the Chief of Engineers, Dept. of the Army, Washington, D. C.

(d) Experimental; applied research.

(e) Rubble wave absorbers are to be studied in a wave flume to determine criteria for the design and construction of such structures. The study will include investigation of the effects of slope and shape of face of the structure, and size, shape, volume, and porosity of materials on the wave-absorbing characteristics of the structure.

(2935) MODEL STUDY OF BUFFALO HARBOR, LAKE ERIE.

(b) District Engineer, U. S. Army Engineer District, Buffalo, Corps of Engineers, Buffalo, New York.

(d) Experimental; for design.

(e) A 1:125 model is being used to determine (a) the feasibility of relocating the navigation approach channel to the harbor, and (b) whether a detached breakwater is necessary to reduce storm wave action at the proposed new entrance of the approach channel. The model reproduces about 13.2 square miles, including nearly all of Buffalo Harbor and sufficient adjacent lake area to permit reproduction of storm waves from all critical directions. Currents caused by discharge from Lake Erie into Niagara River are simulated.

(g) Results of wave height tests performed to date indicate that a detached breakwater 1,800 to 2,000 feet long will provide adequate protection to the inner harbor against storm wave action, with the relocated navigation approach channel installed.

(2936) MODEL STUDY OF BARCELONA HARBOR, LAKE ERIE.

(b) District Engineer, U. S. Army Engineer District, Buffalo, Corps of Engineers, Buffalo, New York.

(d) Experimental; for design.

(e) The site of the proposed harbor, located on the south shore of Lake Erie, is exposed to waves from west-southwest clockwise to north-northeast. A fixed-bed type, 1:68 model is being used to develop a system of breakwaters to protect pleasure and fishing craft from these wind-generated waves. The model reproduces a sufficient area in the harbor vicinity, up- and downshore and lakeward, to permit generation of waves. Various breakwater schemes will be installed in the model and wave heights measured. Currents generated by waves breaking near the navigation opening will be studied.

(g) Tests indicate that wave action in the protected area is appreciably lessened by

reducing the width of the navigation open-
ing from 200 feet to 150 feet. Also, the
addition of a 100-foot lakeward extension
to the east breakwater would be desirable.

(2937) MODEL TESTS OF CULVERT TAINTER VALVES FOR
NEW LOCK NO. 19, MISSISSIPPI RIVER, KEOKUK,
IOWA.

(b) District Engineer, U. S. Army Engineer Dis-
trict, Rock Island, Corps of Engineers,
Rock Island, Ill.
(d) Experimental; for design.
(e) One of the main features of the filling
and emptying system of new Lock No. 19 is
the longitudinal culverts in each wall,
which are filled and emptied through re-
verse tainter valves. Trial operation in
the prototype disclosed that when the
valves were operated at greater than two-
thirds angular opening, a pulsating load
was transmitted through the strut arm, re-
sulting in reversal of load on the gear
train of such severity that remedial action
is necessary if normal valve operation to
the completely open position is to be
achieved. A 1:12 model is being tested in
an effort to eliminate or reduce the mag-
nitude of the pulsating load. Data con-
cerning rating, flow conditions, pressures,
and valve loading are to be obtained to
evaluate possible changes in the valve de-
sign.
(g) Hoist load test of the original design
valve revealed load reversals at large
openings. Revisions to the valve are now
being studied.

(2938) MODEL STUDY OF SPILLWAY, TOWNSHEND DAM,
WEST RIVER, VERMONT.

(b) District Engineer, U. S. Army Engineer
District, Garrison, Corps of Engineers,
Riverdale, North Dakota.
(d) Experimental; for design.
(e) A 1:50 model reproducing a portion of the
spillway approach channel, a section of
the dam, the spillway and its outlet chan-
nel, and the outlet tunnel, including in-
take and outlet, was used to: (a) Calibrate
the side-channel spillway and determine
the effectiveness of its upstream portion;
(b) study flow conditions in the approach,
over the spillway, and in the outlet chan-
nel; (c) determine the effect of submer-
gence of the crest on the discharge; (d)
determine the minimum amount of rock ex-
cavation necessary in the approach area;
(e) determine if the spillway channel wall
properly confines the flow to the discharge
channel; (f) study the effects of tunnel
discharges downstream of the dam; and (g)
determine the water-surface profiles
throughout the model.
(f) Inactive.
(g) The model study indicated that the spill-
way and approach functioned satisfactorily.
Savings in rock excavation in the side and
discharge channels were effected by rais-
ing the original grades. The spillway

channel wall did not improve flow condi-
tions in the discharge channel sufficient-
ly to justify its cost.

(2939) MODEL STUDY OF STILLING BASIN, EAST BARRE
DAM, WINOOSKI RIVER, VERMONT.

(b) District Engineer, U. S. Army Engineer
District, New York, Corps of Engineers,
New York, N. Y.
(d) Experimental; for design.
(e) A 1:8 model that reproduces the down-
stream end of the outlet tunnel, the out-
let portal, stilling basin, and about 80
feet of the outlet canal is being used to
study means of increasing the discharge
capacity of the existing East Barre Dam
so that it will pass safely a maximum
probable flood based on recently revised
meteorological and hydrological data.
(g) Model tests indicated that the existing
stilling basin did not adequately dissi-
pate energy at flows above 500 cubic feet
per second.

(2940) MODEL STUDY OF SPILLWAY, MCGEE BEND DAM,
ANGELINA RIVER, TEXAS.

(b) District Engineer, U. S. Army Engineer
District, Fort Worth, Corps of Engineers,
Fort Worth, Texas.
(d) Experimental; for design.
(e) To verify spillway discharge coefficients
and resulting required length of weir,
tests were conducted on a 1:12 model of
a section of the spillway and approach
and exit areas.
(f) Testing completed.
(g) Tests indicated that a vertical-face
broad-crested weir located at elevation
176.0 was satisfactory for all conditions
of discharge. The model showed that this
design was more efficient than computa-
tions had indicated, and that predicted
backwater had no effect on discharge
characteristics.
(h) Final report in preparation.

(2941) MODEL STUDIES OF KEYSTONE DAM, ARKANSAS
RIVER, OKLAHOMA.

(b) District Engineer, U. S. Army Engineer
District, Tulsa, Corps of Engineers,
Tulsa, Oklahoma.
(d) Experimental; for design.
(e) Several models will be required to deter-
mine: The adequacy of design of the
stilling basin, weir, and training walls;
the best spacing for the nine flood-con-
trol sluices; and the alinement and out-
let design of the sluices. A 1:100 gen-
eral model will be used to study flow
patterns in the approach and exit chan-
nels, develop a satisfactory alinement
of the right training walls, and deter-
mine the required spacing of the flood-
control sluices. A 1:36 spillway section
model will be used for the stilling basin
and sluice alinement tests. Final refine-
ments in the sluice outlet design, if

needed, will probably be developed in an existing conduit model at a scale of about 1:20 or 1:25.

(g) A basic series of tests in the 1:36 section model have established the height, location, and spacing of the baffles; the height and location of the end sill; the elevation of the basin floor; and the shape of the conduit outlets.

(2942) OLD RIVER ROCK-FILL CLOSURE DAM MODEL STUDIES.

(b) District Engineer, U. S. Army Engineer District, New Orleans, Corps of Engineers, New Orleans, La.

(d) Experimental; for design.

(e) Initial closure of the present Old River channel will be accomplished by dumping rock into low velocity water. A 1:10 model of the rockfill dam will be constructed in order to test the stability of the downstream slope under critical flow conditions and to determine the maximum amount of seepage which will occur.

U. S. DEPARTMENT OF COMMERCE, BUREAU OF PUBLIC ROADS.

(856) HYDROLOGY OF STORM DRAINAGE SYSTEMS IN URBAN AREAS.

Cooperative with The Johns Hopkins Univ. See page 38.

(1074) HYDRAULICS OF STILLING BASINS.

Cooperative with Colorado State University. See page 14.

(1654) MODEL INVESTIGATION OF FISH-LADDERS IN BOX CULVERTS.

Cooperative with Oregon State College. See page 54.

(1945) ESTIMATING RAINFALL INTENSITY FROM TOPOGRAPHIC PARAMETERS.

Cooperative with Stanford University. See page 66.

(1946) SYNTHESIS OF HYDROGRAPHS FOR SMALL AREAS.

Cooperative with Stanford University. See page 66.

(2066) STUDY OF OPEN CHANNEL CONSTRICTIONS IN A SLOPING FLUME.

Cooperative with Colorado State University. See page 15.

(2134) HEAD LOSSES IN STORM DRAIN JUNCTION BOXES.

Cooperative with University of Missouri. See page 47.

(2266) HYDROLOGIC INVESTIGATIONS OF SMALL DRAINAGE BASINS IN CALIFORNIA.

Cooperative with University of California. See page 10.

(2320) A STUDY OF THE FLOW CHARACTERISTICS OF HIGHWAY CULVERTS.

Cooperative with Iowa Institute of Hydraulic Research. See page 35.

(2435) HYDRAULICS OF PIPE CULVERTS.

Cooperative with National Bureau of Standards. See page 123.

(2540) SCOUR AT BRIDGE CROSSINGS.

Cooperative with Iowa Institute of Hydraulic Research. See page 36.

(2604) FULL-SCALE TEST OF CONCRETE PIPE.

Cooperative with St. Anthony Falls Hydraulic Laboratory. See page 64.

(2767) EDUCATIONAL FILMS ON OPEN CHANNEL FLOW.

Cooperative with Colorado State University. See page 19.

U. S. DEPARTMENT OF COMMERCE, NATIONAL BUREAU OF STANDARDS, Fluid Mechanics Section.

Inquiries concerning Projects Nos. 159, 1477, 1478, 1482, 1742, 2435 and 2436 sould be addressed to the Chief, Fluid Mechanics Section, National Bureau of Standards, Washington 25, D. C.

(159) MODEL LAWS FOR DENSITY CURRENTS.

(b) Waterways Experiment Station, Corps of Engineers, Department of the Army.

(d) Theoretical and experimental; basic and applied research.

(e) To determine model laws for models involving the motion of stratified liquids. The two major problems are (1) the motion of a heavy liquid initially confined in a "lock" when released into a long channel containing a stationary lighter liquid, and (2) the motion of a heavy liquid from a "sea" into a long channel with either still or flowing lighter liquid.

(h) "An Experimental Study of the Motion of Saline Water from Locks into Fresh Water Channels", by Garbis H. Keulegan. NBS Report No. 5168, March 4, 1957. "The motion of Saline Fronts in Still Water", by Garbis H. Keulegan (in preparation).

(1477) TURBULENT EXPANSION OF JETS IN WATER.

(b) Office of Naval Research, Department of the Navy.

(d) Experimental and theoretical; basic research.

(e) To determine experimentally the nature of turbulent expansion of jets in water with relation to Reynolds number, using jets of hot water, salt water, etc.

(h) Report in preparation.

(1478) WIND WAVES.

(b) Office of Naval Research, Department of the Navy.

(d) Experimental and theoretical; basic research.

(e) Includes mathematical and experimental studies of (1) wind tides (setup), (2) growth of wind waves, and (3) surface traction of wind on wavy surfaces.

(1482) INITIAL VELOCITY DISTRIBUTIONS IN SALT WATER WEDGE.

(b) Laboratory project.

(d) Experimental; basic research.

(e) To determine velocities and particle trajectories during initial motion when a gate separating two bodies of liquids of different densities is suddenly opened.

(h) Report in preparation.

(1742) MECHANISM OF TURBULENCE.

(b) Office of Scientific Research, Air Research and Development Command.

(d) Experimental.

(e) To study with the aid of dye-tracer techniques the manner in which turbulence originates and sustains itself in shear flow.

(f) Completed.

(h) Report in preparation.

(2435) HYDRAULICS OF PIPE CULVERTS.

(b) Bureau of Public Roads.

(d) Experimental; applied research.

(e) To determine hydraulic characteristics of various types of culvert entrances and to develop inlets of improved design.

(2436) FLOW OVER HYDROPHOBIC MATERIALS.

(b) Office of Naval Research, Department of the Navy.

(d) Experimental; applied research.

(e) To determine coefficient of hydrophobic disks and plates oscillated in various fluids.

U. S. DEPARTMENT OF COMMERCE, WEATHER BUREAU.

Inquiries concerning Projects Nos. 1011, 1015, 1744, 1745, 1750, 1751, 2437, 2440 to 2443, incl., and 2943 to 2945, incl., should be addressed to Mr. William E. Hiatt, Chief, Hydrologic Services Division, U. S. Weather Bureau, Wash. 25, D. C.

(1011) SHORT RANGE SNOWMELT FORECASTING.

(b) Laboratory project.

(d) Field investigation; operation and applied research.

(e) To develop relations between streamflow resulting from melting snow and appropriate meteorological parameters using a statistical approach.

(f) Inactive.

(g) Testing has been limited due to scarcity of required data.

(1015) MEASUREMENT OF EVAPORATION.

(b) Laboratory project.

(d) Theoretical and field investigation; applied research.

(e) Studies are directed toward the derivations of reliable procedures for estimating evaporation from reservoirs (existing and proposed) and land surfaces, utilizing readily available meteorological data and pan evaporation observations.

(g) Water-loss project at Lake Mead applying methods and techniques developed at Lake Hefner has been completed and final report has been prepared for publication. This project, like the Lake Hefner study, was a cooperative investigation involving Bureau of Reclamation, Navy, Geological Survey and Weather Bureau.
Another such study was made at Felt Lake, on contract with Stanford University, and the observational program has been completed. These data have been analyzed and a report is being prepared for publication.
Evaporation-pan studies are being made at the Silver Hill Observatory, Md. An insulated BPI pan has been installed to study the transfer of heat from the pan to the ground; heat flux plates have been attached to the standard BPI pan in order to obtain a continuous record of the heat flux. Class A pans made of monel metal and stainless steel are being compared with the standard galvanized iron pan.
A study of evapotranspiration has been initiated. The purpose is to develop an accounting method for estimating soil-moisture deficiency. Test on two basins has indicated that the soil moisture deficiency provided an improved antecedent index for rainfall-runoff relations. The procedure is being tested on a third area and then a report will be prepared.

(h) "Water-Loss Investigations: Lake Mead Studies", U. S. Geological Survey Professional Paper No. 298, 1957.
"Meteorological Aspects of Evaporation-Phenomena", by Max A. Kohler, presented at IUGG Meeting in Toronto, Canada, Sept. 1957.
"Computation of Evaporation and Evapotranspiration from Meteorological Observations", by Max A. Kohler, presented at AMS Meeting in Chicago, Ill., March 1957 (mimeograph).

(1744) DEVELOPMENT OF RIVER FORECASTING METHODS.

(b) River Forecasting Centers for Ohio River
Basin, Cincinnati, Ohio; Susquehanna and
Delaware River Basins, Harrisburg, Pa.;
Lower Missouri River Basin, Kansas City,
Mo.; Tennessee River Basin, Knoxville,
Tenn.; Columbia River Basin, Portland,
Ore.; Middle and Upper Mississippi River
Basin, St. Louis, Mo.; Arkansas and Red
River Basins, Tulsa, Okla.; New England
and Hudson River Basins, Hartford, Conn.;
South Atlantic and East Gulf Basins,
Augusta, Ga.; and Middle Atlantic Basins,
Washington, D. C.

(d) Theoretical and field investigation; opera-
tion and applied research.

(e) The purpose of these investigations is to
develop modern river forecast procedures
for all ranges of flow for various streams
of each basin. Procedures include: (1)
rainfall-runoff relations involving con-
sideration of the physics of soil moisture,
vegetative reception, transpiration, evapo-
ration and geological features of the
basins; (2) snowmelt forecasting relations
involving consideration of the physics of
snow and heat transfer; (3) unit hydro-
graphs; and (4) streamflow routing proce-
dures, based upon adaptations of basic hy-
draulic principles, using electronic ana-
logues.

(g) Forecasting procedures have been developed
for key points; refinement of these pro-
cedures and development for other basins
are under way.

(1745) WATER SUPPLY FORECASTS FOR WESTERN UNITED
STATES.

(b) Work being conducted in following field
offices: River Forecast Center, Portland,
Ore.; Water Supply Forecast Unit, Salt Lake
City, Utah; River Forecast Center, Kansas
City, Mo.; and Weather Bureau Office,
Sacramento, Calif.

(d) Theoretical and field investigation; opera-
tion and applied research.

(e) The purpose of these investigations is the
development of precipitation-runoff rela-
tions for water supply forecasting utiliz-
ing statistical methods to correlate pre-
cipitation during the winter with runoff
during the melting season.

(g) Water Supply Forecasts are prepared for
over 300 points in the Western United
States. These forecasts of water year and
residual flow are released in Monthly Water
Supply Forecast Bulletins, January through
May. This research program is of a con-
tinuing nature designed to improve and
extend the present forecasting service.

(1750) CRITICAL METEOROLOGICAL ANALYSIS OF MAJOR
STORMS.

(b) Corps of Engineers, Department of the Army.

(d) Theoretical; basic research.

(e) Detailed hour-by hour analysis of all
meteorological data available during se-
lected major winter rainstorms.

(1751) MAXIMUM STATION PRECIPITATION.

(b) Corps of Engineers, Department of the Army.

(d) Analysis of data.

(e) Tabulations of maximum recorded 1-, 2-,
3-, 6-, 12-, and 24-hour precipitation,
for automatic recording rain gage stations,
by states.

(h) Weather Bureau Technical Paper No. 15,
Ohio nearing completion, parts for other
states (20) completed (listed in previous
years).

(1993) PRESSURE JUMP LINES.

(b) Laboratory project.

(c) Dr. Morris Tepper, Office of Meteorologi-
cal Research, U. S. Weather Bureau,
Washington 25, D. C.

(d) Theoretical and field investigation; basic
and applied research.

(e) Investigate the properties of and the
mechanisms producing pressure jump lines
in the atmosphere. These lines, identi-
fied by means of discontinuities in micro-
barograms, have been found to be correlated
very strongly with severe local storms.
The study is based on (1) observational
data collected from a special field pro-
gram, and (2) theoretical models in which
the pressure jump line is interpreted as
a gravity wave propagating on an inversion
surface between stratified atmospheric
layers.

(g) Medium scale atmospheric disturbances
(mesostructures) are consistently found
which are well ordered and move with
chronologic continuity from one hour to
the next. Local weather is directly
associated with the passage of these
mesostructures.

(h) "Squall Lines, Pressure Jump Lines and
Atmospheric Gravity Waves", by M. Tepper,
submitted for publication to Swiss Aero
Review.
"Mesometeorology - the Link Between the
(Macro) Synoptic Scale and Local Weather",
by M. Tepper (manuscript, U. S. Weather
Bureau) presented at XI General Assembly
of IUGG, Toronto, Canada, September 1957.

(1994) SHORT PERIOD FLUCTUATIONS IN GREAT LAKES
WATER LEVELS.

(b) Laboratory project.

(c) Mr. D. Lee Harris, Scientific Services
Division, U. S. Weather Bureau, Wash.
25, D. C.

(d) Theoretical and field investigation;
basic and applied research.

(e) The continuous records of lake level
gages, belonging to the U. S. Lake Survey
and several other organizations, for the
year 1950 and selected periods of other
years are being examined to learn the
properties of the seiche-like phenomena
observed on the Great Lakes. A theoreti-
cal model, which appears to explain the
observations, has been derived. This

work was undertaken to investigate the possibility of forecasting the floods which are due to the oscillations of the lakes.

(f) Suspended.

(2437) UNITED STATES STORM CHARACTERISTICS PROJECT.

(b) Soil Conservation Service, Department of Agriculture.
(d) Theoretical and field investigation; applied research and design.
(e) Studies to provide rainfall data for design criteria in estimating required capacities of hydraulic structures. Work includes (1) development of a generalized relationship between depth, area, duration and frequency for areas up to 400 square miles, durations of 20 minutes to 24 hours, and return periods from 1 to 100 years; and (2) development of a generalized portrayal of the probable maximum precipitation for areas up to 400 square miles, and durations up to 24 hours in the United States west of longitude 105.
(h) "Rainfall Intensity-Frequency Regime - Part 1 - The Ohio Valley", U. S. Weather Bureau Technical Paper No. 29. Part 2 will be Southeastern United States, and Part 3 will be Middle Atlantic.

(2438) STORM TIDE PREDICTIONS.

(b) Laboratory projects.
(c) Mr. D. Lee Harris, Scientific Services Division, U. S. Weather Bureau, Washington 25, D. C.
(d) Theoretical and field investigation; basic and applied research.
(e) The differences between the observed and predicted tides during storms are being studied with the goal of improving the accuracy of storm tide forecasting.
(g) Empirical methods of forecasting these inundations are being developed and used in the Weather Bureau's hurricane and storm warning service. Continued improvement in these forecasts is expected to result from this research.
(h) "Empirical Methods for Forecasting the Maximum Storm Tide Due to Hurricanes and Other Tropical Storms", by W. C. Conner, R. H. Kraft, and D. L. Harris, Monthly Weather Review, Vol. 85, pp 113-116, 1957. "An Index of Tide Gages and Tide Gage Records of the Atlantic and Gulf Coasts of the United States", by D. L. Harris and C. V. Lindsay, National Hurricane Research Project Report No. 7, Washington, 1957.

(2440) REGIONAL FREQUENCIES OF SELECTED HURRICANE CHARACTERISTICS.

(b) Corps of Engineers, Department of the Army.
(d) Theoretical and field investigation; applied research and design.
(e) Collection, analysis, and presentation of available observations pertinent to hurricane minimum pressure, direction of

movement, speed, wind-structure and other characteristics, and their relationship to each other.

(2441) HURRICANE RAINFALL AND ITS QUANTITATIVE FORECASTING.

(b) Corps of Engineers, Dept. of the Army.
(d) Theoretical and field investigation; applied research and design.
(e) Collection, analysis, and effective presentation of existing data on hurricane rainfall and evaluation of suggested methods of forecasting the intensity and quantity of rainfall from future hurricanes for design of protective works, students of quantitative precipitation forecasting, planning of evacuation procedures, etc.

(2442) HURRICANE WIND ANALYSIS.

(b) Corps of Engineers, Department of the Army.
(d) Theoretical and field investigation; applied research and design.
(e) Development of methods for obtaining detailed wind speeds and directions in hurricanes just above the sea-surface indirectly from available data, which is mostly on land. Also construction by indirect means of detailed analyses of winds over specific areas of the sea where the energy of the wind develops waves and tides damaging to specific coastal areas.
(h) "Hurricane Characteristics Pertinent to the Design of Protective Works in Southern New England", - report submitted to sponsor.

(2443) RADAR-RAINFALL PROJECT.

(b) Laboratory project in cooperation with University of Miami, Coral Gables, Fla., and Texas A and M College, College Station, Texas.
(d) Experimental; operation.
(e) Integration of the instantaneous PPI scope image over time by both photographic process and electronically by electrostatic storage tube, to provide a pattern of accumulated rainfall over an area that can be calibrated with key rainfall observations for the period of integration. To be used in flood forecasting with other radar intelligence.
(h) "Investigation of Rainfall Measurement by Radar" (second report, 1 August 1956 to 1 August 1957) by H. W. Hiser, L. F. Conover, Marine Laboratory, University of Miami. "Use of Radar in Severe Storm Detection, Hydrology and Climatology", by M. G. H. Ligda, S. G. Bigler, R. D. Tarble and L. E. Truppi, Texas A and M Research Foundation, College Station, Tex., 1956. "The Use of Radar in Detecting Flood Potential Precipitation and its Application to the Field of Hydrology", by R. D. Tarble, Masters Thesis, Department of

Oceanography and Meteorology, A and M
College of Texas, 1957.

(2943) RADAR BEACON FOR REPORTING RAINFALL.

(b) Laboratory project.
(d) Experimental; development.
(e) A compact device capable of being installed
in relatively remote areas within line of
sight of a radar. Activated by a tipping
bucket rain gage and pulse signal from the
radar, instrument transmits delayed pulse
which appears on radar scope indicating
accumulated amounts of precipitation.
(g) Initial field installation now operational;
additional beacons being built.

(2944) PROBABLE MAXIMUM PRECIPITATION OVER FEATHER
RIVER AND OTHER CALIFORNIA BASINS.

(b) Corps of Engineers, Department of the Army.
(d) Design and applied research.
(e) Estimate of probable maximum precipitation
over basins in mountainous areas of Calif.
based on simple model of wind flow up oro-
graphic slopes, checked against December
1955 flood-producing storm.
(g) Estimates furnished sponsor. Methods being
refined.

(2945) MECHANICAL FLOOD ROUTING ANALOGUE.

(b) Laboratory project.
(d) Field investigation; operation and applied
research.
(e) A mechanical analogue has been developed
which will solve flood routing based on a
variable lag and variable storage factor
(K). The analogue can be operated by one
person and the size is such that it can be
placed on a desk.
(g) The pilot model has been constructed and
will be tested thoroughly in order to de-
termine refinements necessary.
(h) "Graphical Flood Routing and Related Me-
chanical Analogues," by Max A. Kohler, pre-
sented at Annual Meeting of ASCE, New York,
N. Y. in October 1957.

U. S. DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY.

(690) DISCHARGE THROUGH MULTIPLE OPENINGS.

(b) Laboratory project.
(c) Mr. H. J. Tracy, U. S. Geological Survey,
Atlanta, Georgia.
(d) Experimental; applied research.
(e) Laboratory studies to define the distribu-
tion of flow through multiple bridge open-
ings with any given natural distribution
and varied number, size, and location of
openings.
(f) Laboratory tests and analyses are continu-
ing.

(1221) STEADY STATE ELECTRIC FLOW NET MODELS.

(b) Laboratory project.

(c) Mr. R. R. Bennett, U. S. Geological Sur-
vey, Washington 25, D. C.
(d) Applied research.
(e) Preparation of electric flow net models
using graphite paper, conductive paints,
etc. Includes design and construction of
a variable resistor grid analogous plotter.

(1755) CHARACTERISTICS OF SAND CHANNEL STREAMS.

(b) Laboratory project.
(c) Mr. Tate Dalrymple, U. S. Geological Sur-
vey, Washington 25, D. C.
(d) Field investigation; applied research.
(e) The research is conducted at a 1,900 foot
reach. The following factors are being
investigated; variation of value of "n"
with stage; extent of scour and fill;
reliability with which scoured depths can
be determined by subsequent prodding; and
quantity of suspended sediment in trans-
port.

(1764) COMBINED PHYSIOGRAPHIC AND HYDRAULIC
STUDIES.

(b) Laboratory project.
(c) Mr. Luna B. Leopold, U. S. Geological Sur-
vey, Washington 25, D. C.
(d) Field and office research.
(e) Hydraulic and physiographic factors con-
trolling slope and pattern of natural
river channels.

(1765) SONAR INVESTIGATIONS (EQUIPMENT DEVELOP-
MENT).

(b) Laboratory project.
(c) Dr. A. N. Sayre, U. S. Geological Survey,
Washington 25, D. C.
(d) Development; theoretical laboratory.
(e) To adopt the sonar principle of the fa-
thometer as method of delineating under-
water sediments of moderate thickness
(several hundred feet) and depth to under-
lying bedrock. Development work is pre-
sently in progress to modify and simplify
the procedures of interpretation and use
of the sonar technique for geophysical
investigations on land.

(1995) COMPARATIVE STUDY OF SOIL MOISTURE
EQUIPMENT.

(b) Laboratory project.
(c) Mr. Irwin Remson, U. S. Geological Survey,
Trenton, N. J.
(d) Field investigation; applied research.
(e) A comparative study of all commercially
available instruments for measuring soil
moisture, possible design of new instru-
ments.

(1998) DEVELOPMENT OF INSTRUMENTS AND TECHNIQUES
FOR SUBSURFACE EXPLORATION OF GROUND WATER.

(b) Cooperative with the State of Arizona.
(c) Mr. H. E. Skibitzke, U. S. Geological Sur-
vey, Tucson, Arizona.
(d) Applied research.

(e) To adapt instruments and techniques for solving problems of the occurrence of water in alluvial fill; including electrical resistivity methods, electric logging, and deep well current meters.

(2000) GHYBEN-HERZBERG LENS.

(b) Laboratory project.
(c) Mr. Dan A. Davis, U. S. Geological Survey, Honolulu, T. H.
(d) Field investigation.
(e) Study of ground-water body in marine islands, to determine the relationship of fresh water storage to the geology of the island, rainfall, head, tidal fluctuations, leakage, and draft.

(2210) THERMAL STRUCTURE OF COOLING POND.

(b) Cooperative with Texas Board of Water Engineers.
(c) Mr. Trigg Twichell, U. S. Geological Survey, Austin, Texas.
(d) Field investigation at Lake Colorado City, Texas.
(e) Observations of effect of advected heat upon thermal structure, evaporation, and radiation from cooling pond at power plant.
(f) Field work complete.
(h) Report in preparation.

(2444) REDESIGN OF PRICE CURRENT METER (INSTRUMENT DEVELOPMENT).

(b) Laboratory project.
(c) Mr. A. H. Frasier, Equipment Development Laboratory, U. S. Geological Survey, 1509 Hess Street, Columbus 12, Ohio.
(d) Development.
(e) To design a rotor for Price current meter that can be mass-produced with identical rating calibration and be affected little or not at all by vertical components of the velocity.
(g) Twelve models tested.

(2446) METHODS OF DETERMINATION OF PHYSICAL AND CHEMICAL CHARACTERISTICS OF WATER.

(b) Laboratory project.
(c) Mr. L. L. Thatcher, Quality of Water Branch, Water Resources Division, USGS, Wash., D.C.
(d) Experimental and applied research.
(e) Continuing study and development of methods for analysis of water.
(h) "Modified Zirconium - Eriochrome Cyanine R Determination of Fluoride", by L. L. Thatcher, Analytical Chemistry, pp. 1709-1712, Nov. 1957.
"Colorimetric Method for Determining Arsenic", by H. Levine, in process of publication, open file release.

(2447) RECORDING CONDUCTIVITY OF WATER.

(b) Laboratory project.
(c) Quality of Water Branch, USGS, Wash., D.C.
(d) Laboratory and field study; applied research.

(e) study of performance and utilization of a meter for determining and recording conductivity of water in a stream under field conditions.
(h) "A Study of the Field Performance of a Continuous Conductivity Recorder", by J. D. Weeks, open file release.

(2687) AQUIFER ANALYTICAL METHODS.

(b) Laboratory project.
(c) Mr. R. H. Brown, U. S. Geological Survey, Washington, D. C.
(d) Analytical; applied research.
(e) To develop more versatile and comprehensive methods of determining and evaluating aquifer and ground-water reservoir hydrologic characteristics.

(2688) MECHANICS OF AQUIFERS.

(b) Laboratory project.
(c) Mr. J F. Poland, U. S. Geological Survey, Sacramento, California.
(d) Field investigation; basic and applied research.
(e) To determine the principles and factors involved in the strain, deformation, and compaction of water-bearing rocks resulting chiefly from changes in hydrologic environment.

(2689) DIFFUSIONAL PROCESSES AND HYDRODYNAMICS OF SALT-FRESH WATER INTERFACE IN AQUIFERS.

(b) Laboratory project.
(c) Mr. H. H. Cooper, U. S. Geological Survey, Tallahassee, Florida.
(d) Field and laboratory investigation; basic and applied research.
(e) To determine the factors affecting the distribution of salt water in coastal aquifers subject to salt water encroachment.

(2690) MICROSCOPIC FLOW THROUGH POROUS MEDIA.

(b) Laboratory project.
(c) Mr. E. S. Simpson, U. S. Geological Survey, Mineola, L. I., New York.
(d) Laboratory investigation; basic research.
(e) To determine the factors affecting the pattern of microscopic flow of water and other liquids through porous media.

(2691) ARTIFICIAL RECHARGE THROUGH WELLS.

(b) Cooperative with Arkansas Agricultural Experiment Station and Corps of Engineers, U. S. Army.
(c) Mr. P. E. Dennis, U. S. Geological Survey, Little Rock, Arkansas.
(d) Field investigation; applied research.
(e) Study of the physical and chemical factors affecting the introduction of water in aquifers through recharge wells.

(2692) ANALOGUE COMPUTER FOR ANALYSIS OF GROUND-WATER FLOW SYSTEMS.

(b) Laboratory project.

(c) Mr. H. E. Skibitzke, U. S. Geological Survey, Tucson, Arizona.
(d) Theoretical study and instrument development.
(e) Development of the physical and mathematical theory of ground-water flow systems and construction of an analogue computer for analyzing ground-water flow systems under transient conditions.

(2694) FLOW OF WATER OVER WEIRS AND SPILLWAYS.

(b) Laboratory project.
(c) Prof. C. E. Kindsvater, Georgia Institute of Technology, Atlanta, Georgia.
(d) Library search, re-analysis and correlation of published data, plus some original research.
(e) A comprehensive study of the discharge characteristics of practical forms of weirs and spillways. Objectives include the publication, in generalized form, of available experimental data.
(h) "Discharge Characteristics of Rectangular Thin-Plate Weirs", by Carl E. Kindsvater and Rolland W. Carter submitted for publication in Proceedings, of ASCE.

(2695) CONTINUOUS DISCHARGE RECORDS IN TIDAL STREAMS.

(b) Laboratory project.
(c) Prof. H. R. Henry, Michigan State University, Lansing, Mich.
(d) Theoretical and applied research.
(e) The objective of this study is to develop methods of obtaining continuous discharge records in tidal streams. Equations developed from theoretical considerations will be checked by field observations.

(2696) VELOCITY DISTRIBUTION IN NATURAL STREAM CHANNELS.

(b) Laboratory project.
(c) Mr. H. J. Tracy, U. S. Geological Survey, Atlanta, Georgia.
(d) Analytical.
(e) Velocity distributions in natural stream channels that represent a wide range in boundary geometry are being studied.

(2698) EVALUATION OF EFFECT OF CHANNEL STORAGE ON PEAK DISCHARGE.

(b) Laboratory project.
(c) Mr. W. D. Mitchell, U. S. Geological Survey, Champaign, Ill.
(d) Analytical and experimental.
(e) The objective of the project is to develop parameters that describe channel storage effectively in an areal correlation of peak flow.

(2699) UNIFORM FLOW IN OPEN CHANNELS.

(b) Laboratory project.
(c) Mr. H. J. Tracy, U. S. Geological Survey, Atlanta, Georgia.
(d) Theoretical and experimental; basic research.
(e) A comprehensive laboratory study of uniform flow in open channels.

(2700) PARAMETERS CONTROLLING THE SHAPE AND PATTERN OF NATURAL STREAM CHANNELS.

(b) Laboratory project.
(c) Mr. M. G. Wolman, U. S. Geological Survey, Washington 25, D. C.
(d) Basic research.
(e) The effect of discharge, load, grain size, and slope will be studied in a small channel free to adjust both bed and side walls.
(h) Report in preparation.

(2701) SEDIMENT TRANSPORT INVESTIGATIONS.

(b) Field project (cooperative with Bureau of Reclamation).
(c) Mr. D. M. Culbertson, U. S. Geological Survey, Lincoln, Nebr.
(d) Field observations and theoretical analysis.
(e) Field and theoretical investigations of the methods, equipment, and computations used for determining sediment movement and the theory of sediment transport. Specifically included are studies on sampling techniques; the effect of water temperature on sediment transport; the relationship of roughness to sediment discharge, slope, and width-to-depth ratio; the effect of Kolk action on the vertical distribution of velocity and sediment; the revaluation of Von Karmen's Universal Constant of momentum exchange for sediment-laden flow; the influence of suspended sediment on vertical distribution of velocity; the influence of ice cover on sediment transport; the influence of cobble-bed streams on total sediment transport; and other related sediment transport problems.
(g) Evaluation of the equal-transit-rate (ETR) method of measuring suspended-sediment discharge indicates the method is satisfactory when properly used. Tests of a new (petrolatum-type) surface bed-material sampler give results that compare favorably with the core-type of sampler. The modified Einstein procedure is adequate for computing total load when water temperature is near freezing. In general low values of roughness are associated with low temperatures and high sediment loads on Middle Loup River at Dunning, Nebraska.
(h) "Investigations of Some Sedimentation Characteristics of a Sand-Bed Stream", by D. W. Hubbell and others, open file release.

(2702) ROUGHNESS AND WATER-SEDIMENT MOVEMENT IN ALLUVIAL CHANNELS.

(b) Laboratory project.
(c) Dr. D. B. Simons, Geological Survey, Colorado A and M College, Fort Collins, Colorado.

(d) Basic and applied research.
(e) Attention is currently directed to the determination and correlation of factors which influence water-sediment movement and roughness in alluvial channels under selected laboratory conditions. Subsequent studies will be conducted for the purpose of defining (1) variation in roughness properties with the range in standard deviation and skewness exhibited by bed material in natural streams; (2) influence of fine suspended sediments on roughness and sediment transport; (3) relation of these findings to channel geometry; and (4) adaptation of findings to conditions in natural streams.

(2703) EVAPORATION SUPPRESSION.

(b) Work coordinated with, and executed in conjunction with, that of the Southwest Research Institute and the U. S. Public Health Service.
(c) Mr. G. E. Harbeck, U. S. Geological Survey Denver, Colorado.
(d) Basic and applied research.
(e) Evaporation from test reservoirs, both with and without monomolecular surface films, is being measured. Laboratory tests will be made to determine the effects of monomolecular films on emissivity and reflectivity and on the vertical humidity profile.

(2946) STUDY OF AGGRADATION AND DEGRADATION IN MODEL STREAMS.

(b) Laboratory project.
(c) Dr. M. Gordon Wolman, U. S. Geological Survey, Washington 25, D. C.
(d) Basic research.
(e) Aggradation and degradation of channel beds will be studied by varying the amount of seepage along the channel and by varying sediment concentration.

(2947) STUDY OF AGGRADATION AND DEGRADATION IN ALLUVIAL CHANNELS.

(b) Laboratory project.
(c) Dr. Lucien M. Brush Jr., U. S. Geological Survey, Washington 25, D. C.
(d) Basic research.
(e) A study of channel and hydraulic parameters associated with aggradation and degradation in Muddy Creek, near Baggs, Wyoming.

(2948) ANALOGUE MODEL ANALYZER FOR STEADY-STATE GROUND-WATER FLOW PROBLEMS.

(b) Laboratory project.
(c) Mr. R. W. Stallman, U. S. Geological Survey, Washington 25, D. C.
(d) Theoretical study and instrument development.
(e) Design and development of a variable-resistance grid analyzer for use in analyzing steady-state ground-water flow problems in which the transmissibility varies in space.

(2949) ULTRASONIC FLOW METER.

(b) U. S. Geological Survey.
(c) Mr. R. W. Carter, U. S. Geological Survey, Washington 25, D. C.
(d) Experimental.
(e) The objective of this study is to investigate the feasibility of measuring discharge in a natural stream channel by ultrasonic means.

(2950) SEDIMENT TRANSPORT AND CHANNEL ROUGHNESS IN NATURAL AND ARTIFICIAL CHANNELS.

(b) Laboratory project.
(c) Mr. Thomas Maddock Jr., U. S. Geological Survey, Washington 25, D. C.
(d) Basic research.
(e) Field and laboratory studies, original and other investigations will be analyzed in terms of sediment movement, channel roughness, shear distribution in channel prism and other effects on shape of natural channels.
(h) Report in preparation.

JOINT INTER-AGENCY INVESTIGATION.

(194) A STUDY OF METHODS USED IN THE MEASUREMENT AND ANALYSIS OF SEDIMENT LOADS IN STREAMS.

See Department of the Army, Corps of Engineers, St. Paul District, page 104.

(2951) A STUDY OF THE DENSITY OF SEDIMENTS DEPOSITED IN RESERVOIRS.

(b) Inter-Agency Committee on Water Resources, Subcommittee on Sedimentation.
(c) U. S. Bureau of Reclamation, Denver, Colo.
(d) Experimental; applied research and development.
(e) Development of a radio-isotope-densitometer to determine density of deposited sediments in place.
(f) Laboratory tests completed. Field tests are now being made by interested agencies.
(h) "Density Measurement of Saturated Submersed Sediment by Gamma Ray Scattering", Chemical Engineering Laboratory Report No. SI-11, U. S. Bureau of Reclamation, Denver, Colorado.

U. S. DEPARTMENT OF THE INTERIOR, BUREAU OF RECLAMATION.

Inquiries concerning the following projects should be addressed to Mr. L. N. McClellan, Assistant Commissioner and Chief Engineer, Bureau of Reclamation, Denver Federal Center, Denver, Colorado.

(1495) YELLOWTAIL DAM SPILLWAY AND OUTLET WORKS.

(f) Completed.
(h) "Hydraulic Model Studies of Yellowtail Dam Spillway and Outlet Works", Report Hyd-414, by G. L. Beichley is in preparation but temporarily suspended.

(1498) WEIR STANDS--IRRIGATION WATER DISTRIBUTION SYSTEM.

    (f) Completed.
    (h) Preparation of report suspended.

(1499) CANAL TURNOUT--METER LOCATION.

    (f) Completed.
    (h) Preparation of report suspended.

(1502) STABLE CHANNEL STUDIES--TRACTIVE FORCES REQUIRED TO MOVE NONCOHESIVE MATERIALS.

    (b) Laboratory project.
    (d) Experimental; for design.
    (e) Tests are conducted in a trapezoidal channel to determine tractive forces required to scour observed sizes of materials in a pit run gravel mixture. Information obtained will be used in design of canals in noncohesive materials and in choosing gravel for protective canal cover.
    (f) Active; testing and analysis continuing.
    (h) Progress report for straight section in preparation.

(1777) SIPHON SPILLWAY STUDIES.

    (b) Laboratory project.
    (d) Combined field investigation and applied research; for design.
    (e) Purpose is to develop improved design for lower priming head and short priming time. Attempts will be made to design a partialization device to regulate the degree of prime through the automatic control of air intake, thereby enabling the siphon to operate more or less continually at reduced flow rather than intermittently at full capacity.
    (f) Tests of standard design complete; tests on proposed design in progress.
    (g) Hydraulic characteristics of proposed design partially defined; new model to be equipped with partialization device.
    (h) Formal report not yet written. Paper delivered at October 1957 meeting of ASCE, New York, "Some Experiments with Emergency Siphon Spillways", by Warren B. McBirney, preprint copies available.

(2005) CAVITATION EROSION ON ROUGHENED SURFACES.

    (f) Work completed.
    (h) "Cavitation Erosion of Roughened Concrete Surfaces", PAP-88, by D. Colgate.

(2009) NIMBUS DAM SPILLWAY.

    (f) Completed.
    (h) "Hydraulic Model Studies of Nimbus Dam Spillway, Folsom Unit, American River Division, Central Valley Project, California", Report Hyd-431, by T. J. Rhone.

(2015) DEVELOPMENT OF A LOW VELOCITY CURRENT METER.

    (f) Completed.
    (h) Preparation of report suspended.

(2224) SHERBURNE LAKES OUTLET WORKS.

    (f) Suspended.
    (h) Report to be prepared.

(2451) WU-SHEH DAM TUNNEL SPILLWAY.

    (f) Completed.
    (h) "Hydraulic Model Studies, Wu-Sheh Dam, Tunnel Spillway, Wu-Sheh Dam Project, Taiwan, China", Report Hyd-430, by T. J. Rhone.

(2454) GATE SLOT STUDIES.

    (f) Completed.
    (h) Results will be included in a general report on gate slots.

(2455) CASA COLORADA CHANNEL ALINEMENT--MIDDLE RIO GRANDE.

    (b) Laboratory project.
    (d) Experimental; for design.
    (e) Tests are continuing on a 1:140 horizontal and 1:22 vertical scale model to aid in channelization and levee protection by steel jetties. A 1:16 sectional model is being used to study small areas of the jetty field. Plastics with a specific gravity of 1.06 are being used as suspended sediment in the distorted model.
    (g) The energy loss in typical jetty layouts has been investigated for a limited number of depths and velocities.
    (h) Progress report in preparation--paper presented at Hydraulics Division meeting, ASCE, Madison, Wisconsin, August 22-24, 1956--"Use of Steel Jetties for Bank Protection and Channelization in Rivers", by Enos J. Carlson and Phillip F. Enger.

(2457) EROSION AND TRACTIVE FORCE STUDY OF UNLINED AND EARTH-LINED CANALS.

    (b) Laboratory and field project.
    (d) Experimental; for design.
    (e) Soil samples and hydraulic measurements to determine tractive force distribution are being taken on stable canals and on canals where deposition and scouring are occurring. Different soil types are being investigated and main stress will be on cohesive soils. Correlation of hydraulic and soils data will improve data for design.
    (f) Hydraulic measurements have been taken on 44 field sites. Additional sites will be selected as needed.
    (h) Progress Report of Canal Erosion and Tractive Force Study, Lower-cost Canal Lining Program, General Report No. 21, by P. F. Enger and J. Merriman.

(2458) HEATED PRECIPITATION STORAGE GAGE.

    (f) Completed.
    (h) Report to be prepared.

(2705) TRINITY DAM MORNING-GLORY SPILLWAY.

(b) Laboratory project.
(d) Experimental; for design.
(e) Trinity Dam utilizes a morning-glory entrance in conjunction with a 50° sloping tunnel. Testing of 1:30 scale model is concerned with development of crest profile which will operate with acceptable pressures and, with placement of auxiliary rib vanes and aerated deflector, to minimize spiral flow in shaft and tunnel, and to ventilate tunnel. A 1:80 scale model is being used to develop a flip bucket at the end of the spillway tunnel.
(g) Spillway crest profile and antivortex features determined; tests on both models continuing.
(h) Reports to be prepared on studies in both models.

(2707) HYDRAULIC DOWNPULL STUDIES--PALISADES-TYPE SLIDE GATES AND GLENDO FIXED-WHEEL GATES.

(f) Completed.
(h) "Model Studies of Hydraulic Downpull Forces That Act on the Palisades-type Regulating Slide Gate, and on the Glendo Fixed-wheel Gate", Report Hyd-421, by W. P. Simmons, Jr. and D. Colgate.

(2709) FLOW CHARACTERISTICS IN PIPE WITH SQUARE-CORNERED ENTRANCE.

(f) Completed.
(h) "Flow Characteristics in a Pipeline Downstream from a Square-Cornered Entrance", Report Hyd-422, by H. A. Babcock and W. P. Simmons, Jr.

(2710) TUMUT AND EUCUMBENE TUNNEL CONTROL STRUCTURES.

(f) Completed.
(h) "Hydraulic Model Studies of the Control Structures for Tooma-Tumut and Tooma-Eucumbene Tunnels", Report Hyd-429, by W. P. Simmons, Jr.

(2711) GATE SLOT MODIFICATIONS TO IMPROVE SUB-MERGED PERFORMANCE OF SLIDE GATES--TOOMA-TUMUT AND VAQUERO CONTROL STRUCTURES.

(f) Completed.
(h) "Air and Hydraulic Model Studies of the Effect of Moving the Slots Upstream in a Slide Gate, and of Reducing the Slot Size Near the Floor", Report Hyd-432, by W. P. Simmons, Jr.

(2712) VAQUERO DAM OUTLET WORKS.

(f) Completed.
(h) Report in preparation.

(2714) ANCHOR DAM SPILLWAY AND OUTLET WORKS.

(f) Completed.
(h) "Hydraulic Model Studies of Anchor Dam (Earthfill) Tunnel Spillway and Outlet Works", Report Hyd-437, by G. L. Beichley.

(2715) ROBLES DIVERSION DAM.

(f) Completed.
(h) "Hydraulic Model Studies of Robles Diversion Dam Spillway", Report Hyd-427, by G. L. Beichley.

(2717) FLAMING GORGE DAM OUTLET WORKS.

(f) Cancelled. Structure eliminated from project planning.

(2718) TRINITY DAM OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:28 scale model was constructed to develop the stilling basin design.
(f) Completed.
(g) The length of the basin was reduced so that upstream undercurrents did not carry bed material into the basin. The slope of the discharge channel was increased to fit the natural slope at which bed material was deposited during operation at design flow.
(h) Report in preparation.

(2719) GLEN CANYON DAM SPILLWAY.

(b) Laboratory project.
(d) Experimental; design.
(e) The model is being built to a scale of 1:63.5 and will include the tunnel spillways on both sides of the river, the curved arch dam, the outlet works, the powerhouse and a section of the Colorado River upstream and downstream from the dam. The tunnel spillways are to be modeled in transparent plastic so that flow conditions can be thoroughly investigated. Other features to be studied will be the approach channels to the spillway, the discharge capacity of the spillways, the pressures on the face of the crests, the flip buckets at the downstream portal of the tunnels, and the effect in the river when all structures are discharging.

(2722) YANHEE DAM SPILLWAY.

(f) Completed.
(h) "Hydraulic Model Studies of Yanhee Dam Spillway, Yanhee Project, Thailand", Report Hyd-428, by W. E. Wagner.

(2723) HOWARD PRAIRIE DAM OUTLET WORKS.

(f) Completed.
(h) "Hydraulic Model Studies of Howard Prairie Dam Outlet Works, Rogue River Basin Project, Oregon", Report Hyd-436, by W. E. Wagner.

(2724) FRICTION FACTOR TESTS IN LARGE PRESSURE CONDUITS.

(b) Laboratory project.
(d) Field investigation; design.

(e) Purpose of the project was to determine friction factors by prototype tests of large concrete pressure conduits up to 20 feet in diameter. This information is needed to correlate friction factor data with smooth interior finishes of concrete conduits that can be consistently produced with present-day construction methods. Tests have been completed on an inverted siphon with a diameter of 14,666 feet where the friction-head measuring section was 372 diameters in length. Friction-head values were determined by use of four-tap piezometer installations that isolated siphon entrance and outlet losses from the measuring section. Average velocities of flow were determined by salt-velocity discharge measurements.

(g) The test described above covered a Reynold's number range from 4.7×10^6 to 8.1×10^6 and the friction factor as computed by use of the Darcy-Weisbach formula was 0.011 compared to 0.015 used for design.

(h) Report to be prepared.

(2726) VANE SHEAR TESTER FOR FIELD AND LABORATORY USE.

(f) Completed.
(h) "Design, Assembly, and Use of a Portable Vane Shear Tester", Report No. Hyd-434, by P. F. Enger and T. J. Rhone.

(2952) WOODSTON DIVERSION DAM--GENERAL STUDIES OF HEADWORKS AND SLUICEWAY STRUCTURES.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:8 undistorted scale hydraulic model was used to study the headworks and sluiceway of Woodston Diversion Dam of the Missouri River Basin Project. Tests were conducted to develop a design that would pass the maximum amount of sediment through the sluiceway, thus keeping as much sediment as possible from entering the canal headworks.
(g) A satisfactory design was found by using guide walls and a headworks overhanging sill to control flow near the headworks and sluiceway.
(h) Report in preparation.

(2953) STUDIES OF WIND WAVES ON CANALS.

(b) Laboratory and field project.
(d) Experimental; for design.
(e) Field studies are being conducted to develop relationships to predict wave characteristics in canals from data concerning canal size and wind velocity and direction. Testing facilities will be built for the laboratory study and earth materials, and protective covers will be subjected to simulated wind waves.
(g) Motion pictures have been obtained of wind waves occurring in the field, and wave height and frequency data have been obtained from the film.
(h) Report will be prepared following completion of the tests.

(2954) GLEN CANYON TUNNEL PLUG OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) Air and hydraulic model studies are being made to develop the rectangular bellmouth shapes and conduit alinement for 3, slide-gate-controlled, 7 x 10.5-foot outlet conduits in the left, 41-foot-diameter diversion tunnel.
(f) Testing in progress.
(g) Air tests have shown that satisfactory pressures will exist on the surfaces of the proposed bellmouths for any symmetrical or unsymmetrical operation of the gates. Hydraulic tests are showing that smoother flow will occur in the tunnel downstream from the outlet works when the conduit alinements are changed from the initial design.
(h) Report to be prepared.

(2955) CAVITATION IN SUDDEN ENLARGEMENTS DOWNSTREAM FROM GATE VALVES.

(b) Laboratory project.
(d) Experimental; for design.
(e) Tests are being made at heads from 200 to 400 feet to determine the critical cavitation indexes for gate valves operating at partial openings and discharging into pipe sections 1.5, 1.75, and 2.0 times the nominal valve diameter.
(f) Testing in progress.
(h) Report to be prepared.

(2956) MURRUMBIDGEE-EUCUMBENE TUNNEL FIXED-WHEEL GATE AND STILLING BASIN.

(b) Snowy Mountains Hydro-Electric Authority, Australia.
(d) Experimental; for design.
(e) Studies were made to determine the proper bottom shape of the 6- x 7-foot fixed-wheel gate, and the configuration of the gate chamber flow passages, to permit the gate to be used for control for heads up to 145 feet. A control structure stilling basin was designed which would permit a tranquil flow to enter the 10-mile-long unlined tunnel.
(f) Testing completed.
(h) Report in preparation.

(2957) PAONIA DAM SPILLWAY AND OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:36 scale model was constructed to develop the design of the side channel spillway entrance, the spillway chute, the stilling basin, and the outlet works tunnel junction with the spillway chute.
(f) Completed.
(g) The side channel basin floor was elevated to make full use of a shallower basin and to eliminate a step between the basin floor and the chute floor. The height of

the chute walls was increased for more freeboard. Five stream-lined baffles were placed on the stilling basin floor to reduce wave heights on the tail water surface. The outlet works tunnel junction with the spillway chute performed very well as preliminarily designed.

(h) Report has been temporarily suspended.

(2958) HOLLOW-JET VALVE STILLING BASINS FOR OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for research.
(e) A 3-inch hollow-jet valve and a model stilling basin were constructed to generalize the basin dimension.
(f) Completed.
(g) A stilling basin for the discharge from a hollow-jet valve has been developed and standardized for general use.
(h) Report in preparation.

(2959) STILLING BASINS FOR SLIDE GATE CONTROLLED OUTLET WORKS.

(b) Laboratory project.
(d) Experimental; for research.
(e) A model is being constructed to generalize stilling basin dimensions, using either one or two slide gates.

(2960) FLAMING GORGE DAM SPILLWAY.

(b) Laboratory project.
(d) Experimental; for design.
(e) A 1:36 scale model has been constructed to develop satisfactory features for the approach channel, crest section, and tunnel transition of the spillway.
(f) Tests in progress.
(g) A satisfactory approach channel has been developed, and good flow conditions in the crest section and transition have been obtained by the use of an unusual center pier. Tests are being continued to determine other hydraulic characteristics of the transition and tunnel sections.
(h) Report to be prepared.

(2961) CLEAR CREEK POWER CONDUIT SURGE TANK.

(b) Laboratory project.
(d) Experimental; for design.
(e) To design parts for the proper control of flow between the 44-foot-diameter surge tank and a 16-inch-diameter stand pipe or riser in the center of the surge tank, and to design a vibration-free crest for the top of the 210-foot-high riser.
(f) Completed.
(h) "Model Studies of Clear Creek Power Conduit Surge Tank, Trinity River Division, Central Valley Project", Report Hyd-438, by D. Colgate.

U. S. DEPARTMENT OF THE NAVY, DAVID TAYLOR MODEL BASIN.

Inquiries concerning the following projects should be addressed to Commanding Officer and Director, David Taylor Model Basin, Washington 7, D. C.

(467) DEVELOPMENT OF A HOT-WIRE INSTRUMENT FOR TURBULENCE MEASUREMENTS IN WATER.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Flow instrumentation.
(e) Development of the hot-wire technique for measuring turbulent velocity components in water.
(f) Completed.
(g) During the course of development of such an instrument, exchange of information was frequently made between TMB and the Iowa Inst. of Hydraulic Research. Most of the inherent difficulties associated with the use of hot-wire in water have been eliminated. However, the accumulation of dirt on the wire still prevents obtaining a stable wire calibration. To this end, Iowa has suggested the use of a hot-film plated on the end of a glass wedge. It was decided then to suspend the work at DTMB pending the outcome of the Iowa University efforts. The hot-film instrument has been purchased by TMB recently. It shows a stable linear calibration. A report on the theoretical study of the time response of a coated wire has been published.
(h) "Time Constants and Frequency Response of Coated Hot-Wire Used As Turbulence-Sensing Elements", by A. Borden, TMB Report 952 of June 1957.
"Summary Report on the Development of a Hot-Wire Turbulence-Sensing Element for Use in Water", by R. G. Stevens, A. Borden and P. E. Strausser, TMB Report 953 of December 1956.

(470) FLOW INSTRUMENTATION.

(b) David Taylor Model Basin.
(d) Flow instrumentation research.
(e) Various types of flow instrumentation are being developed including an electrical analogy to obtain pressure measurements on and about various bodies in a fluid. Hot film anemometer for turbulence measurements in water and a micro pressure range for the shallow water towing basin.
(g) An electrolytic tank has been developed for obtaining the pressure distribution about cylindrical bodies. A single probe method is used to obtain potential differences on the body and a double probe method is used for obtaining the potential differences in the surrounding field. Improvements in design of probe and carriage are under way. A hot-film anemometer for turbulence measurements in water is being tested.
(h) "The David Taylor Model Basin Micro-Pressure Range", by J. A. Luistro, J. P. Craven and P. Eisenberg, TMB Report 779, June 1957.

(709) THEORY OF WAVE RESISTANCE.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) A mathematical study of the theory of wave resistance for the purpose of establishing methods for extending the theory to the analysis of ship resistance. Studies will include the general theory of waves in liquids and will encompass a review of existing theory and comparisons with existing experimental data.
(g) A synopsis has been written on the application of theory to the calculations of wave resistance.
Calculations were made to obtain general information about wave resistance of submerged bodies of revolution. The forms considered are ellipsoids, Rankine ovoids, and a simple family of streamlined bodies. A report of this work is to be published.
(h) "The Wave Resistance of a Floating Slender Body", by W. E. Cummins, dissertation presented to American University, May 1956.

(710) RESEARCH ON MAIN INJECTION SCOOPS AND OVER-BOARD DISCHARGES.

(b) Bureau of Ships, David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Investigations to determine the characteristics of a broad series of injection scoops and discharges to provide design data for use in design of future high-speed ships.
(g) An improved method for estimating the velocity profile and thickness of a ship's boundary layer is being developed.
(h) "Boundary Layer Investigation on the USS TIMMERMAN EAG152 (ex-DD828)", by C. I. Cayre Jr., TMB Report No. 1170, to be published.

(711) CAVITATION RESEARCH.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Research on the mechanism and effects of cavitation phenomena including the physics and analytical description of steady-state cavities in real and ideal fluids and investigations of the inception of cavitation, the growth and collapse processes of transient cavities, and the effects of cavitation on the forces on underwater bodies. Studies will be made on the application of linearized theory to problems in cavitation. Additional studies will be made on the effects of roughness elements on cavitation inception and of body form on cavitation and degassing. Cavitating vortex cores as produced by shear flows will be investigated. Such cavitating sources have been observed on appendages to ships and may be responsible for flow noise excitation at high speeds.
(g) In one case the excitation of vibration of a ship has been traced to cavitation on rudder. (See DTMB Report 1158).
(h) "An Investigation of Flow Excitation of Vibration of the USS FORREST SHERMAN,

DD931", by M. S. Macovsky, R. J. Duerr and D. A. Jewell, TMB Report No. 1188, to be published.

(1268) STUDIES OF THE INTERACTION OF APPENDAGES AND BODIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamics of submerged bodies.
(e) An investigation of potential flow and boundary layer phenomena associated with appendage-body combinations in order to determine the nature of interference effects. The generation of lift and moments by fins in non-uniform flows is being studied. A theoretical and experimental investigation is being made in order to determine the mutual interference effects of appendages and bodies. In addition an experimental investigation is being carried out in order to determine the effects of non-uniform flows on the lift and moments of a low aspect ratio fin.
(f) Suspended.

(1505) EFFECT OF TRANSVERSE CURVATURE ON FRICTIONAL RESISTANCE.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) Studies to determine the effect of transverse curvature on the frictional resistance to motion of a body through a liquid. Shear stress measurements and velocity profiles will be obtained at 10-foot intervals along a 150-foot length of towed cylinder. Results will be extended to determine flat plate resistance without surface and edge effects normally present.
(f) Suspended.
(g) A theoretical analysis of the laminar flow case for slender cylinders has been made to determine significant parameters and the expected magnitude of the curvature effect. Equipment for the experimental phase has been completed.

(1506) STIMULATION OF TURBULENCE ON SHIP MODELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) Development of a turbulence stimulating device which will insure adequate turbulence in the boundary layer over the entire length of any ship model. Empirical and theoretical studies will be conducted to evaluate the relative effectiveness of turbulence rods, trip wires, sand roughness, isolated stubs, noise makers and vibrators. Their relative effectiveness will be calculated by studying the model resistance and the character of the boundary layer flow around ship models as determined by the dye-method, the chemical compound, and the hot-wire survey method.
(f) Suspended.
(g) The work of the previous year was devoted to the study of the stimulating effect of studs and the development of the technique of the chemical compound. The effect

of various stimulators on the BSRA model has been established and the evaluations work will compare the results for each stimulator with the results obtained by the English tanks. The evaluation of the stimulators used is still continuing.

(1511) SERIES 60 SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Experimental and theoretical investigation of the effect of changes in certain features of hull shape on the seaworthiness characteristics of a series of ship models. Three single screw ship forms of 0.60, 0.70 and 0.80 block coefficient have been adopted for this purpose. Tests to determine the motion and speed reduction characteristics of the 0.60 block model were completed.
(g) The phase between pitching and heaving motion affects the seaworthiness characteristics such as wetness, slamming, and speed reduction. Consequently this phase relationship was further studied both experimentally and theoretically.

(1512) EFFECTIVENESS OF BILGE KEELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental testing.
(e) Measurements of the amplitudes of roll versus rolling moment and frequency at or near resonance for a ship model with and without bilge keels; the increase in resistance of a model due to rolling and roll-induced yawing; and the lift, drag, and torque developed by fins. Data will be used in arriving at criteria for the design of fin stabilizers.
(f) Completed.
(g) Roll tests have been made in the basin on a ship model with and without bilge keels. Also, wind tunnel measurements have been made to determine the effect of variation in fin stabilizers on lift, drag, and torque characteristics.

(1514) MANEUVERING CHARACTERISTICS OF SINGLE-SCREW VESSELS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental testing.
(e) Measurements of side forces on propeller, rudder, and hull of a single-screw ship model during successive phases of starting, stopping, and backing maneuvers.
(f) Inactive.
(g) A test program has been formulated. A side-force dynamometer has been designed and completed. Testing is expected to begin when priority considerations permit.

(1516) STUDIES OF RESISTANCE PREDICTION METHODS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) The theoretical possibility of separating the viscous and wave drag for surface

flows by means of wake surveys has been demonstrated. Experiments are to be performed on ship models to verify the practical possibility of using this method to improve resistance predictions.
(f) Suspended.
(g) Instrumentation for the wake survey, including pitot rakes and traversing mechanisms are completed. The use of pressure transducers rather than manometric systems is being investigated.

(1517) VORTEX-EXCITED BODIES IN A MOVING STREAM.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental basic research.
(e) Measurements have been made of fluctuating lift and drag forces on a 2- and 4-inch circular cylinder towed in minature Model Basin. Further work will include wind tunnel investigations of the relationship between Strouhal number and shape for a family of struts in an attempt to correlate wake frequency and shape parameters. In addition, an investigation will be made of the spanwise correlation of vortex shedding on circular cylinders as a function of Reynolds number.
(g) For a rigid cylinder fluctuating lift coefficients of the same order of magnitude as the steady drag coefficient have been found in the sub-critical range of Reynolds numbers. There is evidence for lack of two-dimensionality in the vortex shedding.
(h) "Vortex-Induced Vibration Studies", by M. S. Macovsky, DTMB Report 1190, in preparation.

(1521) 36-INCH VARIABLE PRESSURE WATER TUNNEL.

(b) Bureau of Ships; David Taylor Model Basin.
(d) New facility.
(e) Design and construction of a 36-inch variable pressure water tunnel for investigation of propulsion, cavitation, and noise characteristics of propellers as well as tests on sub-surface bodies. Interchangeable test sections of open and closed jet type will be provided. The maximum design speed is 85 f.p.s.
(g) A construction contract was awarded in December 1955 with a completion date in early 1958.

(1522) WAVEMAKER STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research and facility development.
(e) Theoretical and experimental studies of surface wave generators to develop criteria for the design and construction of a large-scale wavemaker installation. A program of research on wave absorbers is also underway. Prerequisite to this latter investigation is the development of practical means for evaluating the effectiveness of a given absorber.
(f) Completed.

(g) A small pilot model of a pneumatic wave-maker has been developed and successfully operated. Improvement has been made in the means of controlling amplitude and frequency of generated waves. A much larger pneumatic wavemaker has been installed in the 140-foot model basin, and has been in regular operation generating waves for ship model tests. A 51-foot wide pneumatic wavemaker has been installed in the deep water basin. A method of making measurements and determining wave absorption characteristics therefrom has been developed analytically. The accuracy with which wave height can be determined has been improved by the development of an electronic wave-height recorder which operates on a change of capacitance principle.

(1778) HYDRODYNAMIC NOISE.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Investigations of the characteristics of underwater noise associated with various hydrodynamic phenomena such as cavitation, bubble oscillation, turbulence and splashing.
(g) Experimental and theoretical studies have been made of noise produced by cavitation, splashing, oscillating air bubbles, and turbulence.
(h) "Some Measurements of the Fluctuating Pressures and Velocities in the Wake Behind a Cylinder", by M. Strasberg and R. D. Cooper, Paper 1-707 in Proceedings of 9th International Congress on Applied Mechanics, Sept. 1956.

(1779) TURBULENT BOUNDARY LAYERS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) A theoretical and experimental investigation of the velocity profile and wall shearing stresses in turbulent boundary layer. In order to provide a simple and accurate determination of shear stress at the wall, the use of surface tube technique for measuring this characteristic has been investigated in both zero and adverse pressure gradients.

(1780) BUBBLE FLOW STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Theoretical computations of bubble paths for various shapes to determine points of collision and conditions for non-collision will be made. The validity of the theory will be checked experimentally in a few cases.
(h) "Experimental Study of Bubbles Moving in Liquids", by W. L. Hagerman, Paper in Trans. ASCE, Volume 121, 1956.

(1781) ROTATING-ARM AND MANEUVERING BASIN.

(b) Bureau of Ships; David Taylor Model Basin.
(d) New facility.
(e) Design and construction of a circular basin of 260-foot diameter with a rotating arm whose radius can be varied from 18 to 120 feet. To be used for towing tests of surface and sub-surface models. Also, design and construction of a maneuvering basin 350 feet long and 230 feet wide, equipped with traveling bridge and towing carriages, and wavemakers for the purpose of making maneuvering tests on ship models.
(g) Construction contract awarded in May 1956 with a completion date in early 1959.

(1782) SHIP MOTIONS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Applied research.
(e) Determination of ship motions in a regular seaway when coupling exists between heave and pitch. The work is to be based on the linear theory and is a continuation of work on uncoupled motion. It is intended to extend the applicability of the linear theory to a larger number of vessels of various type.
(f) Inactive.

(1783) MATHEMATICAL SHIP LINES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical research.
(e) Development of a suitable method for the mathematical determination of ship lines which can be applied to a wide variety of ship forms especially to those of modern design.
(g) A method has been developed for the mathematical fairing of graphical lines. This is a first step toward the development of a flexible system of mathematical ship lines. Future work is directed toward the development of a system of mathematical lines which will permit the derivation of a hull form for a given set of parameters.

(1784) RESEARCH ON UNSTEADY FLOW PROBLEMS-- UNSTEADY EFFECTS ON STABILITY DERIVATIVES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Theoretical and experimental.
(e) Studies of the effect of oscillation frequency and amplitude, speed of advance and geometry on the stability derivatives of an oscillating body in a fluid.
(f) Discontinued.
(g) The effect of the various parameters has been studied with a spheroid of 7 to 1 fineness ratio. It was shown that unsteady effects may be of importance especially when combined with non-linearity.

(1785) RESEARCH ON UNSTEADY FLOW PROBLEMS-- GENERAL THEORY.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Theoretical research.

(e) A general theoretical study of the field of time-dependent hydrodynamic phenomena.

(f) Discontinued.

(g) Flows with d'Alembert type unsteadiness, unsteady jet problems, decay of vorticity, d'Alembert flows, Gerstner's waves, potential waves, have been studied. It was shown that the dimensionless parameter which describes the unsteadiness of general fluid motion reduces to the conventional Strouhal number (or dimensionless frequency ratio) for oscillatory flows under certain conditions.

(1786) STUDIES OF THE SLAMMING OF SHIPS.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Experimental and theoretical.

(e) Computations and measurements of the maximum pressure and impact forces on the bottoms of slamming ships for the purpose of developing design criteria to effect their reduction.

(g) Studies with ship models were made to determine hydrodynamic impact forces on ships. Regular and confused seas were studied to determine conditions favorable for slamming.

(h) "Experiments on Rotational Impact", by F. N. Schwartz and M.D. Bledsoe, TMB Report 1145.

(1788) WAX DEVELOPMENT.

(b) David Taylor Model Basin.

(d) Experimental testing.

(e) Development of a wax composition and manufacturing techniques for the manufacture of ship models up to 30 ft. on water-line length.

(f) Completed.

(g) The blend developed is entirely suited to the climatic conditions existing in Wash., D.C. The strength of this material is such that all types of models, including submarines, may be constructed and handled with no greater care than is given to corresponding wood models. Ninety-one models, varying in length between 19 and 24 ft. and in weight between 1,000 and 4,500 lbs., and four 30 ft. models have been successfully manufactured and tested since the development of this new wax blend. The introduction of wax model construction technique has resulted in a substantial saving in time and cost of ship model manufacturing at TMB.

(h) The following reports are being reviewed prior to publication:
"The Development of a N-Butyl Methacrylate Wax Blend for Manufacturing Wax Models at TMB", by W. Hinterthan.
"Development and Application of a Wax Composition for the Manufacture of Experimental Ship Models", by W. Hinterthan.
"Methods to be Followed in the Blending of Wax for TMB Wax Model Production", Memorandum, by W. Hinterthan.

(1789) PRESSURE DISTRIBUTION ON SHIP MODELS.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Frictional resistance research.

(e) Measurements of pressure distribution and resistance with photographs of wave profiles and flow lines for a series of ship models. Data are to be used for the design of turbulent boundary layer stimulators and the improvement of resistance prediction technique.

(g) A bank of diaphragm-type pressure gages has been constructed to determine the pressure distributions, and tests on a specific model are in progress. Tests on the first model have been completed.

(2018) SERIES 60 - RESISTANCE OF VARIOUS RELATED HULL FORMS.

(b) Bureau of Ships; Maritime Commission; David Taylor Model Basin.

(d) Experimental testing.

(e) The dependance of resistance upon the coefficients of hull form for a practical range of single-screw ship forms is to be determined. The history of the project, the scope of the proposed series is given in (h) for Series 57. The resistance results of the original Series 57 models were somewhat disappointing and therefore careful thought was given to the problem of improving the original parents. As a result, new parent forms have been drawn out, together with necessary contours and models run for resistance. The new family was designated number Series 60.

(f) Completed.

(g) It is believed that the new Series 60 contours now are such as to justify their use as a starting point for future research in a number of fields. Suggestions as to such systematic research were made in the earlier paper, and include the evaluation of the effect of LCB position, L/B and B/H ratios etc.

(2019) PROPELLER EXCITED VIBRATION.

(b) David Taylor Model Basin and Society of Naval Architects and Marine Engineers.

(d) Experimental basic research.

(e) Investigation, measurement and prediction of propeller excited vibratory forces on ship models.

(g) Development of the instrumentation and testing technique for single screw vessels has been completed and refined. Tests are in progress to correlate model results with the Gopher Marines full scale results. Investigations are planned to determine the effects on vibratory force of hull form propeller design and location and rudder design and location. Measurements of instantaneous pressure have been made on the hull of USS TIMMERMAN and on the hull of a 30 foot model of USS TIMMERMAN. The results agreed well with the predicted scaling law. A report is being prepared.

(2229) NEAR SURFACE EFFECTS.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Hydrodynamic research.
(e) A mathematical study of the forces and moments acting on bodies due to the proximity of a free surface. The studies will include both the case in which the surface is initially undisturbed and the case in which there are disturbances originating at a distance.
(g) Methods have been developed for computing the forces and moments acting on bodies of revolution, both due to waves generated by the body itself and to regular trains of waves.

(2230) THEORY OF SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) A theoretical and experimental study of factors affecting the seaworthiness of ships, for the purpose of developing procedures for predicting their motion.
(g) Tests have been completed on two geometrically similar ship models of different lengths. The analysis of these tests will aid in estimating the validity of model tests for predicting full-scale behavior. A ship model has been oscillated in heave and pitch to determine the dependency of the damping and added mass forces on speed, frequency and amplitude of oscillation. Comparisons will be made with theoretical methods currently used to compute these forces.
(h) "A Study of the Forces and Moments on a Surface Ship Performing Heaving Oscillations", by Paul Golovato, Journal of Ship Research, Vol. 1, No. 1, April 1957.

(2231) HYDRAULIC ROUGHNESS STUDIES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Frictional resistance research.
(e) Theoretical and experimental research on methods for analyzing and predicting the frictional resistance of arbitrary rough surfaces, especially the painted surfaces of ship hulls. The geometrical characteristics of arbitrary rough surfaces are to be analyzed by amplitude-frequency spectra while the hydrodynamic characteristics are to be analyzed by similarity laws.
(g) The low frequency characteristics of the roughness records necessitate the development of a low frequency spectrum analyzer. The analytical procedures for predicting the frictional resistance of arbitrary rough surfaces from similarity laws have been completed. A method has been derived for predicting full scale resistance of arbitrary rough surfaces from tests of model plates. Relations for the local skin friction and shape parameter have been derived for use in calculating the development of turbulent boundary layers in pressure gradients for rough surfaces. Boundary layer measurements are being made in a wind tunnel on randomly rough surfaces using a floating element dynamometer.
(h) "The Frictional Resistance and Turbulent Boundary of Rough Surfaces", by P. S. Granville, TMB Report 1024.

(2232) PRESSURE AND VELOCITY DISTRIBUTIONS ON TWO-DIMENSIONAL AND AXISYMMETRIC THREE-DIMENSIONAL FORMS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Potential flow research.
(e) Investigate analytic techniques for determining the pressure and velocity distribution on two-dimensional and axisymmetric three-dimensional forms. The solution is to be amenable to coding for UNIVAC computation.
(g) An iterative solution has been developed and coded for the UNIVAC. The pressure distribution for a number of bodies whose pressure distribution is known have been completed and verified. Some difficulty is experienced however, with convergence in certain portions of the calculations.

(2233) THE STRUCTURE OF TURBULENCE IN BOUNDARY LAYERS AND WAKES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Turbulence research.
(e) A study to investigate the behavior of the basic turbulence quantities in boundary layer and wake flows. Investigations of the effect of background turbulence level on the turbulence characteristics of the wake behind two-dimensional forms and circular disks will be continued.
(g) Experimental results indicate that the intensity decay and width increase of the turbulent wake in its downstream course behind three-dimensional bluff bodies (discs and plates) are in agreement with those theoretically predicted. Future tests will be extended to include practical configurations which will be investigated in both unpowered and powered conditions.

(2234) SURFACE WAKES BEHIND TOWED STRUTS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Hydrodynamic research.
(e) Research on the mechanism of plume and wake formation of surface piercing struts, including the determination of wave drag, spray drag, and induced drag for geometrically varied series.
(f) Inactive.
(g) Tests on a series of struts have been completed.

(2235) LIBERTY SHIP SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical.
(e) Thorough seaworthiness investigations of a Liberty Ship and a modified Liberty Ship Hull. The aspects of this investigation includes speed reduction, ship motion, and slamming. Model experiments have been conducted with 5-foot models in waves. This work will be extended to

20-foot models and full-scale sea trials.
(f) Inactive.

(2236) OSCILLATING PRESSURES IN THE VICINITY OF PROPELLERS.

(b) David Taylor Model Basin.
(d) Experimental and theoretical; applied research.
(e) Studies of the oscillating pressures on boundaries and in the free space produced by propeller operation. The purpose of the work is to determine the magnitude of the hydrodynamic propeller excited vibratory forces acting on ship's hulls and the effect of operating parameters.
(f) Completed.
(g) Experimental results have been completed.
(h) "The Measurement of Thrust Fluctuation and Free-Space Oscillating Pressures for a Propeller", by A. J. Tachmindji and M. C. Dickerson, DTMB Report 1107, January 1957. "The Measurement of Oscillating Pressures in the Vicinity of a Propeller", by A. J. Tachmindji and M. C. Dickerson, DTMB Report 1130, April 1957.

(2237) LIFTING SURFACE THEORY OF PROPELLERS.

(b) Cooperative with Bureau of Ships.
(d) Theoretical; applied research.
(e) Studies of the corrections on lifting line theory which arise from the finite extent of the blades.
(f) Application of an approximate lifting surface theory is completed. Development of a rigorous theory temporarily inactive.
(g) The available results are being applied to propeller design methods.

(2238) THE EVALUATION OF THE EFFECT OF SHIFTING THE LONGITUDINAL CENTER-OF-BOUYANCY (LCB) UPON THE RESISTANCE AND PROPULSIVE CHARACTERISTICS OF VARIOUS RELATED HULL FORM OF SERIES 60.

(b) David Taylor Model Basin.
(d) Experimental testing.
(e) Four models for each of the five block coefficients, to which the parent models were built, were constructed from the Series 60 contours. Resistance tests were conducted for each of these hulls to find the effect on resistance of varying the LCB. Concurrently, the relation between the propulsion coefficients and LCB position was obtained from propulsion tests.
(f) Completed.
(g) The effect of the LCB positioning on the propulsive coefficients has been obtained. Also an optimum location of LCB for each block coefficient, of this series, has been established from the resistance characteristics of this hull.

(2239) PROPULSIVE CHARACTERISTICS OF VARIOUS RELATED HULL FORMS - SERIES 60.

(b) Bureau of Ships; Maritime Commission; David Taylor Model Basin.

(d) Experimental testing.
(e) The dependance of propulsion characteristics upon the coefficients of hull form and propeller diameter for a practical range of single-screw ship forms are to be determined. Series 60 parent models are used for this project.
(f) Completed.
(g) The dependance of wake, thrust deduction, propulsive coefficient, etc. upon the block coefficient, propeller diameter, trim etc. has been obtained.

(2462) PITCH REDUCTION STUDIES.

(b) Bureau of Ships.
(d) Experimental and theoretical.
(e) To investigate the effect of horizontal fin appendages on the motion of surface ships in a seaway. A motion prediction theory is being developed and experimental investigations will be conducted.
(h) "Model Experiments with Fixed Bow Antipitching Fins", by G. P. Stefun, TMB Report 1118, in publication.

(2463) STUDIES OF LOW ASPECT-RATIO CONTROL SURFACES.

(b) David Taylor Model Basin; laboratory project.
(d) Experimental investigation; basic research.
(e) Determine the aerodynamic characteristics of a family of low aspect-ratio control surfaces which can be used by the designer of submarines and surface ships. Phase I is an investigation of a family of all-movable control surfaces. Phase II is an investigation of the same family with plain flaps of different chord length.
(f) Phase I, completed; Phase II, active.
(g) The results of Phase I indicate that many of the aerodynamic characteristics of low aspect-ratio surfaces can be accurately predicted from lifting surface theory.
(h) The results of Phase I and comparisons with lifting surface theory are presented in DTMB Report No. 933.

(2464) THE EVALUATION OF THE EFFECT OF CHANGING THE LENGTH TO BEAM (L/B) AND BEAM TO DRAFT (B/H) ON THE RESISTANCE CHARACTERISTICS AND PROPULSIVE COEFFICIENTS FOR THE VARIOUS RELATED HULL FORMS OF SERIES 60.

(b) David Taylor Model Basin.
(d) Experimental testing.
(e) For each block coefficient (C_B) models are being built from the offsets of the model with the optimum location of the longitudinal center-of-bouyancy. This model will have been established by the program - "The Evaluation of the Effect of Shifting the Longitudinal Center-of-Bouyancy upon the Resistance and Propulsive Characteristics of Various Related Hull Forms of Series 60".

(f) Completed.

(h) "Series 60 - The Effect Upon Resistance and Power of Variation in Ship Proportions", by Dr. F. H. Todd, Mr. G. R. Stuntz, and Dr. P. C. Pien, Society of Naval Architects and Marine Engineers paper was presented during November 1957 meeting.

(2466) TOWING EQUIPMENT AND MOTION RECORDING INSTRUMENTATION FOR SHIP MODEL TESTS IN WAVES.

(b) David Taylor Model Basin laboratory project; specfically for TMB's proposed Maneuvering Basin.

(d) Experimental and theoretical.

(e) The purpose of the equipment and instrumentation is respectively, to tow models in waves and to measure and record various types of model motions. Surface models will be tested under partially-restrained conditions, the restraints being those of yaw and sway; or, of yaw, sway, and roll. Model tests will be conducted in head and following seas.

(f) Specifications were completed while the design of the equipment and instrumentation is being done presently.

(2467) DEVELOPMENT OF OCEANOGRAPHIC RESEARCH VESSEL.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Experimental and theoretical.

(e) Prediction and experimental determination of the motion of research vessel in seaway.

(f) Completed.

(2468) EFFECT OF WAVES ON STANDARDIZATION TRIALS.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Experimental.

(e) To establish a method for determining the conditions under which standardization trials might be adversely affected. Experimental studies are underway on models of three typical vessels of varying block coefficients to determine the combination of speed, wave length and wave height which influence smooth water speed. As a byproduct, this work will furnish general information on factors governing speed reduction in a seaway. A theoretical method has been developed to determine added resistance due to waves. It is intended to compare experiment with theory.

(f) Completed.

(h) "Speed Reduction in Waves", by Margaret D. Bledsoe, TMB Report 1083 (awaiting publication).

(2469) INTERNATIONAL COMPARISON TESTS--SEAWORTHINESS.

(b) Bureau of Ships; David Taylor Model Basin Laboratory project.

(d) Experimental and theoretical.

(e) To obtain seaworthiness information for comparison purposes by means of a 10 foot fiber glass plastic self-propelled model of the Series 60, 0.60 block coefficient form. The effect of self-propulsion on the motion and speed reduction characteristics of this model is compared with the effects previously studied by means of a gravity type towing arrangement. Comparison between results obtained in three large basins (DTMB, Wageningen, Haslar), equipped to handle 10 foot self-propelled models, will also be made.

(2470) HELMHOLTZ RESONATOR.

(b) Bureau of Ships; David Taylor Model Basin.

(d) Experimental and theoretical investigation of the excitation of Helmholtz Resonator by fluid flow.

(e) Studies to determine the mechanism of excitation of the Helmholtz Resonator by fluid flow past orifice will be undertaken. The experimental investigation will employ the Low-Turbulence Wind Tunnel. The amplitude of pressure fluctuations in the cavity will be investigated as function of the size, shape and number of orifices, as well as the turbulence characteristics in the boundary layer flow.

(h) "Excitation of Cavity Resonance by Air Flow", by M. C. Harrington, Journal of Acoustical Society of America, Volume 29, p. 187 (1957).
"Experimental Investigation of Cavity Resonance Excited by Air Flow", by M. C. Harrington, presented at the meeting of the Division of Fluid Dynamics of the American Physical Society, New York of 30 January 1956.

(2471) THEORY OF CONTRA-ROTATING PROPELLERS.

(b) Cooperative with the Bureau of Ships.

(d) Theoretical; applied research.

(e) Studies of the theory of contra-rotating propellers without assumptions regarding the orientation of the resultant induced velocity.

(g) Application to open water and wake adapted propellers.

(h) "Effect of Propeller Pitch Changes on Torque Unbalance of Contra-Rotating Propellers", by W. B. Morgan, DTMB Report 1124, March 1957.

(2472) COOPERATIVE TESTS ON A VICTORY SHIP DESIGN.

(b) David Taylor Model Basin; Skin Friction Committee of the International Towing Tank Conference.

(d) Experimental testing; basic research.

(e) The investigation was authorized by the International Committee on "Scale Effect on Propellers and on Self-Propulsion Factors" as part of the international cooperative test program in ship basins. The International Committee will compare the results from the various basins and present a report to the coming

International Conference. The tests will be carried out with a wax model of scale 1:23 equipped with different kinds of stimulators. The friction corrections will be calculated by the various basins according to their methods.

(g) The specified program of model testing has been completed. The required calculation for the power predictions have to be done before the evaluation work can proceed.

(h) Results will be published before the coming International Towing Tank Conference.

(2473) FRICTIONAL RESISTANCE OF GEOSIM MODELS.

(b) David Taylor Model Basin; Skin Friction Committee of the International Towing Tank Conference.

(d) Theoretical; basic research.

(e) Representatives of the various towing tanks of the ITTC have been unable to agree on a friction line. The Skin Friction Committee of the ITTC was therefore directed to develop a universally acceptable "Engineering Line" for use in extrapolating from ship models to full-scale. Model resistance data for geosim series are therefore being assembled and analyzed according to each of several currently proposed friction lines. Resistance data for geosim models tested at TMB are being distributed to other basins for analysis and TMB will analyze all model data from other tanks using the Schoenherr formula.

(f) Completed.

(g) According to present status, the Schoenherr line seems to represent a reliable average friction line.

(2474) CALCULATION OF GOLDSTEIN FACTORS FOR 3, 4, 5 AND 6 BLADED PROPELLERS.

(b) Cooperative with Bureau of Ships.

(d) Theoretical; applied research.

(e) Calculation of Goldstein factors, particularly for the case of large advance ratios where the approximations made in the original equations are not valid.

(f) Completed.

(g) Application to propeller design.

(h) "The Calculations of Goldstein Factors for Three, Four, Five and Six Bladed Propellers", by A. J. Tachmindji and A. B. Milam, DTMB Report No. 1034.

(2727) THE EFFECT OF HUB DIAMETER ON THE OPTIMUM DISTRIBUTION OF CIRCULATION OF PROPELLERS.

(b) David Taylor Model Basin.

(d) Theoretical; applied research.

(e) Studies of the effect of hub diameters on the optimum distribution of circulation.

(g) Calculations have been completed.

(h) "The Calculation of the Circulation Distribution for Propellers with Finite Hub Having Three, Four, Five and Six Blades", by A. J. Tachmindji and A. B. Milam, DTMB Report 1141, July 1957 and International Shipbuilding Progress, September 1957. "The Ideal Efficiency of Optimum Propellers Having Finite Hubs and Finite Number of Blades", by J. W. Shultz, Jr. DTMB Report 1148, July 1957.

(2728) SEAWORTHINESS OF U. S. COAST GUARD VESSELS.

(b) U. S. Coast Guard; David Taylor Model Basin.

(d) Experimental (research and development).

(e) Three designs for a 160 ft. Water Patrol Craft were investigated for seaworthiness characteristics. Experiments were conducted for several wave conditions in order to determine the best design with respect to amplitudes of motions and accelerations, speed reduction in waves, wetness, etc.

(g) The effect of the LCB positioning on the propulsive coefficients has been obtained. Also an optimum location of LCB for each block coefficient, of this series, has been established from the resistance characteristics of this hull.

(h) "Series 60 - The Effect Upon Resistance and Power of Variation in LCB Position", by Dr. F. H. Todd and P. C. Pien, A Society of Naval Architects and Marine Engineers paper, May 1956.

(2729) HULL FORM RESEARCH BY USING A FLEXIBLE MODEL.

(b) David Taylor Model Basin.

(d) Development and experimental work.

(e) A flexible model which can be quickly changed to have any fullness and any shape of section area curve is to be developed first. The effect of section area curve parameters, such as t_F, t_A, C_{PF}, C_{PA}, L_E, L_X, X_F, X_A, etc., upon resistance will be systematically investigated by using this flexible model.

(g) The flexible model has been built. The experimental work will be started very soon.

(2730) MOLECULAR - PHYSICAL SKIN EFFECT.

(b) David Taylor Model Basin.

(d) Experimental; applied research.

(e) The frictional resistance of a "new" plate consisting of a special molecular coating will be compared with the frictional resistance of a hydraulically smooth brass plate and of a mirror smooth glass plate. The test equipment will be designed and constructed to study wave and spray formation for the determination of the true wetted surface. The plate will be tested with maximum speed of 15.0 knots and with various stimulation devices.

(g) The Nikuradse coated plates have been tested. Significant resistance differences between coated and non-coated plates have been measured on a coated brass plate and an uncoated aluminum plate. Since the contours of the leading and trailing edges of the two plates vary

considerably a doubt is raised at whether the coating or the difference in the contours caused the resistance differences. Therefore, an aluminum plate having the same contours as the coated brass plate will be constructed and tested in order to evaluate this phenomena.

(h) "Skin Friction Experiments on Test Plates with Nikuradse Coatings", by W. B. Hinterthan, DTMB Report 1159, August 1957.

(2962) SHIP MOTION.

(b) Bureau of Ships, David Taylor Model Basin.
(d) Field investigation (full scale trials).
(e) An account of seakeeping trials carried out jointly by the Royal Netherlands Navy and the United States Navy with three destroyers.
(f) Complated.
(g) Measurements were made of motions of slamming pressures and of stresses. These were analyzed to determine the effect of the seaway, of speed and of relative course. Evaluation of the three vessels was made based on the foregoing.
(h) Proceedings Symposium on the Behavior of Ships in a Seaway, September 7th - 10th, H. Veenman and Zonen - Wageningen.

(2963) SHIP MOTIONS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Applied research.
(e) Outline of a method for testing models in confused seas and for reducing the observed data to given standard conditions. The introduction of standard conditions is necessary for the proper interpretation of experiments and for the purpose of comparing one model against another. The method will also allow predicting the behavior of the same model in other seaways which depart not too strongly from the test conditions.
(f) Completed.
(h) Proceedings Symposium on the Behavior of Ships in a Seaway, September 7th - 10th, 1957, H. Veenman and Zonen - Wageningen.

(2964) TRANSITION ON A SPHERE AT HIGH REYNOLDS NUMBERS.

(b) Naval Ordnance Laboratory; David Taylor Model Basin.
(d) Experimental basic research.
(e) An experimental investigation of the position of transition from linear to turbulent flow on an 18-inch sphere at a Reynolds numbers approximately 2.2 to 3.5×10^6. The investigation was conducted in both the Transonic Wind Tunnel and the towing basin, using the hot-wire technique to detect transition.
(f) Completed.
(g) The results indicate transition in a region 90° from the stagnation point in agreement with predictions based on neutral stability theory.
(h) DTMB Report 1110, "Measurement of

Transition on a Sphere at High Reynolds Numbers", by E. Y. Hsu and M. S. Macovsky, June 1957.

(2965) HYDRODYNAMIC STUDIES OF THE HEAVE AND PITCH OF HYDROFOIL CRAFT IN REGULAR WAVES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical applied research.
(e) Measurements of the heave and pitch of a model hydrofoil craft have been made and correlated with theoretical predictions given by Weisblum's approximate linerized theory (TMB Report C-479).
(f) Completed.
(g) The theoretical heave and pitch amplitude magnifications are greater than the measured for most conditions, particularly heave magnifications in following seas. The approximate linerized theory is considered qualitatively useful.
(h) "Experimental and Theoretical Studies of Hydrofoil Configuration in Regular Waves", CDR Patrick Leehey, USN, and John M. Steele Jr., October 1957, TMB Report 1140.

(2966) STUDY OF BOUNDARY LAYERS OF SUBMERGED BODIES OF REVOLUTION.

(b) Bureau of Ships, David Taylor Model Basin.
(d) Theoretical and experimental basic research.
(e) Experiments have been carried out on an elongated body of revolution in 8 x 10 ft subsonic wind tunnel. The model consists of a basic body of revolution with removeable model deck, conning tower, and tail control surfaces, to simulate the geometrical form of a submarine. The measurements consisted of boundary layer survey and local skin friction measurements by surface pitot tubes at various angular locations throughout a range of speeds.
(f) Completed.
(g) Results conform to those expected from considerations based on potential flow theory.

(2967) CONTROL SURFACE FLUTTER.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical basic investigation.
(e) Experiments are being conducted with a flutter apparatus to determine flutter speeds as a function of inertias, spring and damping constants. The results will be compared with a simplified rudder flutter theory which can then be applied to design procedures.
(g) Testing is in progress.

(2968) STUDIES OF LIFT FORCES ON HYDROFOILS IN REGULAR WAVES.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical applied research.
(e) Measurements of the lift force on a

restrained foil in regular waves have been made and will be correlated with the quasi-steady lift theory and the unsteady lift theories of Kaplan (ETT Report 506) and Leehey (TMB Report 1077).

(g) No conclusive results at this time.

(2969) FLOW STUDIES ON THREE-DIMENSIONAL FORMS.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental and theoretical basic research.
(e) Pressure distributions and flow studies have been made in a wind tunnel on several shapes similar to those of certain sonar domes. Data will be used in predicting those conditions of ship speed, yaw and pitch which are conducive to cavitation on sonar domes.
(h) "Sonar Dome Cavitation - Correlation Studies on USS TIMMERMAN (EAG152)", by M. S. Macovsky and R. J. Duerr, DTMB Report 1023, May 1956.

(2970) STUDIES OF HYDRODYNAMIC LOADING ON BARE AND FAIRED CABLES.

(b) David Taylor Model Basin.
(d) Experimental investigation; basic research.
(e) Measure the tangential and normal hydrodynamic forces acting on a long cylinder towed at various angles to the stream over a range of Reynolds' numbers. Tests will be made with various degrees of roughness simulating stranded cable, and various trailing-type fairing designs.

(2971) FULL SCALE TRIAL AND MODEL PREDICTION CORRELATION.

(b) Bureau of Ships; David Taylor Model Basin.
(d) Experimental testing and re-evaluation of existing test data.
(e) The accuracy of full scale power predictions from model test results depends upon the selection of the proper roughness allowance (ΔC_f) to be used in model calculations. The results of approximately 32 trial correlation tests will be analyzed and new model tests conducted to compile data on the variation of ΔC_f with ship type.
(g) This work has been started and is scheduled for completion by July 1958. The presentation of a paper to the Society of Naval Architects and Marine Engineers is projected.

U. S. DEPARTMENT OF THE NAVY, NAVAL BOILER AND TURBINE LABORATORY.

(1523) HIGH PRECISION POWER INSTRUMENTS.

(b) Bureau of Ships and Office of Naval Research, Department of the Navy.
(c) Commanding Officer and Director, U. S. Naval Boiler and Turbine Laboratory, Naval Base, Philadelphia 12, Pennsylvania.

(d) Experimental; applied research.
(e) For improvement of fluid flow measurement. Work is currently being undertaken to determine the effect of two phase flow. Data to date have been obtained for moisture contents in the order of 20 percent.
(g) Preliminary results indicate that additional correction for wet steam is essential over and above compensation for density.

(2731) EFFECT OF PIPE ROUGHNESS ON ORIFICE METER ACCURACY.

(b) American Gas Association.
(c) American Gas Association, 420 Lexington Ave., New York 17, New York.
(d) Experimental; applied research.
(e) This project is under the cognizance of the A.G.A. Supervisory Committee to Study Pipe Roughness. The scope of the project is, initially, limited to investigation of the effect of pipe roughness on two-inch meter runs using water as a media.

U. S. DEPARTMENT OF THE NAVY, NAVAL ORDNANCE TEST STATION.

Inquiries concerning Projects Nos. 2477 and 2972 should be addressed to the Commander, U. S. Naval Ordnance Test Station, Attn: Mr. John C. Waugh, 3202 East Foothill Blvd., Pasadena, California.

(2477) WATER ENTRY CAVITY MODELING.

(b) Bureau of Ordnance, Navy Department.
(d) Experimental; basic research.
(e) For missile water entry at high speeds, the initial regime of underwater trajectory motion takes place with a cavity. It is known that cavity size and shape affect the underwater trajectory behavior of the missile. Hence successful modeling of underwater trajectory in cavity motion necessarily includes modeling of the cavity. The purpose of this experimental project is to investigate the importance of gas-density scaling in conjunction with Froude and cavitation-number scaling in water-entry cavity modeling.
(f) Modeling studies completed.
(g) The oblique water entry of a truncated-cone missile forms a cavity which is sensitive to variations in the gas density coefficient, particularly in the range $0.4 < \rho' < 0.8$. One-to-one scaling of Froude number and gas-density coefficient with or without scaling of the cavitation number, resulted in excellent cavity modeling, but when the gas-density coefficient was not scaled modeling did not occur. All scaling techniques modeled the position of the missile during the first 20 diameters of underwater travel.
The cavities and trajectories of a right-cylinder missile are almost independent of scaling conditions for the first 15 diameters of underwater travel. Beyond 15

diameters, however, they and the missile attitude are greatly affected by changes in either cavitation number or gas-density coefficient. No modeling can be expected unless both parameters as well as the Froude number are scaled.

(h) "Water-Entry Cavity Modeling. Part 1. Vertical Cavities", by J. G. Waugh and G. W. Stubstad, China Lake, Calif., NOTS, 8 Oct. 1956 (NAVORD Report 5365, NOTS 1597). "Water-Entry Cavity Modeling. Part 2. Oblique Cavities", by G. W. Stubstad and J. G. Waugh, China Lake, Calif., NOTS (to be published as NAVORD 5365, NOTS 1597).

(2972) WATER-ENTRY PITCH MODELING.

(b) Office of Naval Research, Navy Department.
(d) Experimental; basic research.
(e) The purpose of this project is to develop a technique whereby the water-entry and underwater trajectory in cavity behavior or proposed service missiles can be rapidly and economically predicted by the use of small-scale models.
(f) Modeling studies completed.
(g) Water-entry pitch modeling studies were made using (a) one-to-one Froude and cavitation number scaling and (b) one-to-one Froude and cavitation number and gas-density scaling. Prototype missiles consisted of six full scale (22.4-inch diameter) dummy Mk 25 aircraft torpedoes with ogive and disk-ogive heads. Head configurations consisted of 1.5- and 3.5-caliber ogives, a hemisphere, disk 0.25- and 0.1-caliber ogives and a disk-cylinder head. Launchings were made with fresh water with atmospheric pressure over the water surface. Nominal prototype water-contact conditions were: 400 feet per second velocity, -20.5-degree trajectory angle, and zero angle of attack. Two-inch diameter geometrically and dynamically similar models of the prototype missiles were launched with fresh water under scaled water-contact conditions. Both prototype and model water-entry data were obtained by photographic techniques. Modeling studies were made over approximately 5 calibers of missile water penetration. Studies with one-to-one Froude and cavitation number scaling were made on all heads. Modeling to within the accuracy of the prototype data was obtained for all heads except the disk 0.1-caliber ogive which showed the least change in water-entry pitch. It is concluded that the technique may be inadequate for heads which show small change in water-entry pitch. Studies with one-to-one Froude and cavitation number and gas-density scaling were made on the hemisphere, disk 0.1-caliber ogive and disk-cylinder heads. Modeling to within the accuracy of the prototype data was obtained. It is concluded that the technique will be adequate for all head configurations, and can be used to model simultaneously missile water-entry and underwater trajectory in cavity behavior.
(h) Report in preparation.

U. S. DEPARTMENT OF THE NAVY, OFFICE OF NAVAL RESEARCH.

For sponsored projects see the following:

TENNESSEE VALLEY AUTHORITY, Hydraulic Data Branch.

Inquiries concerning all TVA projects should be addressed to Mr. Albert S. Fry, Hydraulic Data

Branch, Tennessee Valley Authority, Knox-
ville, Tennessee.

Hydraulic Operations and Tests Section.

(731) SOUTH HOLSTON DAM, SURGE TANK MODEL STUDY.

(d) Experimental; for design.
(e) A 1:50 model of the penstock and surge
chamber was used to determine (1) the ori-
fice size and characteristic shape to pro-
duce favorable pressure and water surface
elevations to be expected in the surge
chamber; and (2) the operational character-
istics or the selected design.
(f) Model studies completed.
(g) With the proper orifice between the riser
and the surge chamber as satisfactory re-
sults can be obtained as with the differen-
tial riser type of surge tank.
(h) Report in preparation.

(739) CHEROKEE DAM, SLUICE RATING.

(d) Field investigation; operation.
(e) Measurement of discharges and differential
pressures in the sluices, supplemented by
model test data, will be used to establish
the discharge ratings for the eight sluices.
Tables of discharge for any gate opening
at any headwater elevation within the oper-
ating range are to be prepared.

(745) FONTANA DAM, SLUICE RATING.

(d) Field investigation; operation.
(e) Model tests, checked by field measurements,
are to be used in determining the discharge
ratings for all anticipated operating con-
ditions. Discharge tables for operating
purposes will be prepared.
(f) Model studies completed.

(758) CHEROKEE DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Periodic checks and observations will be
made on the various hydraulic appurtenances
to determine the operating characteristics
of the structures and the effect of opera-
tion on the structures.
(g) Measurement of pressures in the sluice bar-
rel have been obtained and will be compared
with pressures obtained in model tests.
The apron and sluice barrels were inspect-
ed in 1953 to determine the effect of in-
termittent operation during the past 11
years.
(h) Report in preparation.

(759) DOUGLAS DAM, PROTOTYPE CHECK TESTS.

(d) Field investigation; applied research.
(e) Periodic checks and observations will be
made on the various hydraulic appurtenances
to determine the operating characteristics
of the structures and the effect of opera-
tion on the structure.
(g) Measurement of pressures in the sluice bar-
rel have been obtained and will be compared
with pressures obtained in model tests.
The apron and sluice barrels were inspected
in 1953 to determine the effect of inter-
mittent operation during the past 10 years.
(h) Report in preparation.

(762) SOUTH HOLSTON DAM, SURGE TANK PROTOTYPE
CHECK TESTS.

(d) Field investigation; applied research.
(e) The prototype installation was equipped to
allow testing in a manner similar to that
used in the model studies which established
the design. A check on the model accuracy
can thus be obtained.
(g) Initial tests made in February 1950.

(1038) HALES BAR DAM, SPILLWAY APPROACH STUDIES.

(d) Experimental; for design.
(e) Tests are made on a 1:65 model to deter-
mine effect of the remains of cofferdam
structures upstream of the spillway on the
spillway discharge and to determine amount
of the obstructions which should be re-
moved.
(f) Model tests completed.

(1534) FORT PATRICK HENRY DAM, SPILLWAY MODEL
STUDIES.

(d) Experimental; for design.
(e) Tests are being conducted on a 1:50 scale
and 1:112.5 scale model to determine the
apron design, training wall dimensions,
and other related data.
(f) Model studies completed.
(g) An apron using a single row of rectangular
baffle blocks was developed on the 1:50
scale model. This apron was then used in
the 1:112.5 scale model and the necessary
appurtenant structures developed. Of main
interest in the developed design was the
lack of training walls. Studies to deter-
mine the effect of vegetative growth on
the island areas below the spillway showed
which areas must be kept free of growth and
which may be allowed to grow up. Installa-
tion completed and instruction manual par-
tially completed and issued.
(h) Report in preparation.

(1536) VHF RADIO GAGES FOR REPORTING RAINFALL AND
RIVER STAGES.

(d) Experimental; development.
(e) Standard FM tone modulated 169 - 172 Mc.
radio equipment has been modified to trans-
mit pulsed signals produced in a specially
designed electro-mechanical converter unit
(keyer). This keyer can be directly
operated for river stage measurement by the
conventional float system. By use of an
electrical servo system, rainfall caught in
a standard weighing type gage can be trans-
mitted to the keyer unit. Standard VHF
radio station transmitter-receiver units
have been modified for use as automatic
repeater units. A printing type recorder
operated by a standard VHF, FM receiver

suitably modified, records and prints all transmitted signals on a 5-inch tape. All transmitting units are supplied with at least 3 days emergency power in case of AC power failure. Suitable signals indicate when any gage is on emergency power.

(g) Seven receiving systems which include 19 stream gages, 22 rainfall gages, 13 repeater stations, and 7 receivers have been installed. Some units have operated for 3 years very satisfactorily. Keyer unit has been patented.

(h) "Automatic VHF Radio Telemetering of Hydrologic Data", by James A. Dale, ASCE Proc. Paper No. 1278, Jour. Hydraulics Div., Vol. 83, No. HY3, June 1957.

(1794) WATTS BAR LOCK PROTOTYPE TESTS.

(d) Field investigation; applied research.
(e) The prototype installation was equipped with piezometers to allow checking of culvert and port pressures and discharges. The culverts and ports were designed from model studies. Thus, measurement on the prototype would provide model-prototype verification data.
(f) Complete field tests were conducted in 1952.
(h) Reduction of data is being completed.

(1796) KINGSTON STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDIES.

(d) Theoretical and field investigation; design.
(e) The condenser water intakes and outlets draw water from and discharge into Watts Bar Reservoir (Tennessee River). During the warmer portions of the year this reservoir becomes stratified and the inflowing waters pass through the reservoir as density currents. By means of theoretical considerations and field observations, the proper location and shapes for the intakes and outlets were determined and the probable intake temperature calculated.
(g) Six-point recording temperature gages were installed on the Tennessee, Clinch, and Emory Rivers and data obtained during the period of stratification in 1953 and 1954. Velocity and temperature profile measurements were made at eight sections in the Clinch and Emory Rivers for period of steady flow to define thermal density underflow. Theoretical analyses were made to show the benefits that could be derived by the installation of a submerged dam in the Clinch River below the mouth of the Emory River to divert the density underflow up the Emory River. Studies indicate that temperature reductions effected by the structures will result in coal savings of $100,000.00 annually. The cost of the structures is about $400,000.00.
(h) Report in preparation.

(1797) GALLATIN STEAM PLANT, CONDENSER WATER INTAKE TEMPERATURE STUDY.

(d) Theoroetical and field investigation; design.

(e) The condenser water intakes and outlets are to draw water from and discharge into the proposed Old Hickory Reservoir (Cumberland River). The entire setup is to be analyzed to determine the type of flow conditions to be expected in the reservoir; the temperatures to be expected at the inlets; and the best design for the inlets and outlet structures.

(g) Single-point temperature recorders were installed at six stations which, in combination with turbine intake temperature recorders at three upstream dams, will be used to determine temperature increases between points on the Cumberland River for various conditions. Data are being collected and evaluated.

(2241) KINGSTON STEAM PLANT - CONDENSER COOLING WATER CONDUIT LOSS.

(d) Experimental; for design.
(e) Longitudinal interior support was required for 96-inch concrete pipe conduit. A study was made of the relative loss for a six-inch thick vertical concrete wall, I beams separated by 4-1/2 inch pipe columns and I beams separated by streamlined 4-1/2 inch pipe columns.
(f) Laboratory studies completed; partial field tests performed.

(2479) WILSON LOCK HYDRAULIC MODEL STUDIES.

(d) Experimental; for design.
(e) The new Wilson lock will be 110 feet long, 675 feet center-to-center pintles with a 100-foot maximum lift. Three models are projected: A 1:36 scale model of a single transverse lateral with 12 ports to determine proper lateral and port designs; a 1:16 scale model of lock chamber, intakes, culverts, gates, and other details to determine overall designs; and a 1:100 scale model of the river and navigation channel confluence to study navigation problems.
(f) Laboratory studies completed on the 1:36 and 1:16 scale models. Studies are continuing on the 1:100 scale model.
(g) The basic design for the filling and emptying systems was determined from the model studies. Filling will be achieved through the use of 6 lateral culverts each containing 12 equally spaced ports 3.5 ft high by 1.5 ft wide. The upper three laterals will be fed from the landward main culvert and the lower three laterals by the riverward culvert. At minimum tailwater elevation only 23 ft of water cushion is available at the bottom of the controlling reverse-flow tainter valves. Dangerously low pressures were eliminated by use of a fast initial opening rate followed by a slow rate for the major portion of the opening and by modifications of the valve shape and of the upper seal nose design. A stepped lateral design was found necessary to produce stable flow conditions.
(h) Report on lock filling and emptying system in preparation.

(2973) REVISION TO PRESENT WILSON NAVIGATION LOCK.

(d) Experimental; for design.
(e) Upon completion of the new Wilson Lock con-
struction, the tailwater in the navigation
canal at the dam will be lowered 10 feet.
To make the present two-lift lock operable
under the new conditions, the lower chamber
floor will be lowered 10 feet and a new
filling and emptying system provided.
(f) Model studies are under way to determine
the exact hydraulic design to be used in
the renovations.

(2974) DEVELOPMENT OF IMPACT TUBE-PRESSURE TRANS-
DUCER TURBULENCE PROBE.

(d) Experimental; applied research in field
investigations.
(e) Development of a turbulence probe and
auxiliary analog computer for field use.
(f) Development active.
(g) Based on project (578) of Mass. Inst. of
Tech., a turbulence probe for use in
natural streams is to be developed. An
analog computer which will produce auto-
correlation factors directly from the pres-
sure cell data is also under development.

Hydraulic Investigation Section.

(764) DETERMINATION OF SEDIMENT CARRIED IN SUS-
PENSION BY TENNESSEE RIVER AND TRIBUTARIES.

(d) Field investigation; basic research.
(e) To provide data for estimating effective
life of storage reservoirs, and loss of
soil from the land. Samples of water were
collected periodically at stream gaging
stations in the watershed, analyzed to de-
termine the sediment content, and corre-
lated with river discharge to determine the
suspended sediment load at each station.
(h) Report in preparation.

(765) EVAPORATION IN THE TENNESSEE BASIN.

(d) Field investigation; applied research.
(e) To provide data for estimating reservoir
losses and derive a general rule, applica-
ble to the Basin, permitting computation
of evaporation from pans at six locations
in Basin, together with standard meteor-
ological readings.
(h) "Precipitation in Tennessee River Basin",
published in monthly and annual bulletins.

(768) PRECIPITATION IN TENNESSEE RIVER BASIN.

(d) Field investigation; basic research.
(e) A comprehensive study of rainfall and other
weather phenomena for purposes of water
dispatching and improvements in water con-
trol; storm studies as related to maximum
precipitation, rainfall-runoff, spillway
design and operation, etc.
(h) Monthly bulletin, "Precipitation in Tenn.
River Basin." Also annual summary.

(769) RESERVOIR AND STREAM TEMPERATURES.

(d) Field investigation; basic research.
(e) Study of water utilization and water move-
ment as concerns industrial plant locations
and stream pollution. Variations in tem-
perature from surface to bottom in reser-
voirs throughout the year are determined
by soundings, and by continuous recording
gages in natural streams.

(771) GALLERY DRAINAGE IN LARGE DAMS.

(d) Field investigations; design.
(e) Weirs are placed in main galleries and
drainage measured as check on tightness
and stability.

(785) SEDIMENTATION OF EXISTING RESERVOIRS.

(d) Field investigation; basic research.
(e) Selected ranges in reservoirs are probed
and sounded, volumetric samples are col-
lected and analyzed, quantity and distri-
bution of sediment are computed to deter-
mine deposition by stream, probable life
of reservoir, effect of sediment storage
on navigation channels and sedimentation
of downstream reservoirs, and probable
sedimentation in future reservoirs.
(h) "Measurement of Sedimentation in TVA
Reservoirs", by Edwin H. McCain, ASCE
Proc. Paper No. 1277, Journal of the
Hydraulics Division, Vol. 83, No. HY3,
June 1957.

(786) WATER TRAVEL IN NATURAL STREAMS.

(d) Field investigations; applied research.
(e) Sanitary and chemical changes in water
during passage downstream are determined.
A given mass of water is identified by
electrical conductivity or chemical
titration.
(f) No work done in recent years.

(787) MOVEMENT OF WATER THROUGH LARGE RESERVOIRS.

(d) Field investigation; applied research.
(e) Because of slow water travel, samples are
collected by traverse through lake.
(f) No work done in recent years.
(g) Water entering a reservoir does not inter-
mix with the rest of the reservoir, but
remains as a density current as a result
of the difference in temperature between
the inflowing water and that in the reser-
voir. During certain seasons of the year,
in Watts Bar Reservoir the cold water re-
leased from Norris Reservoir passes up-
stream along the bottom of the Emory River
arm of the former reservoir.

Hydrology Section.

(777) RUNOFF-EROSION INVESTIGATIONS ON SMALL
WATERSHEDS.

(b) Certain projects involve cooperation with
North Carolina State College of Agri. and
Engrg., and The Univ. of Tennessee.
(d) Field investigation and office analysis;

basic and applied research.

(e) To evaluate, hydrologically, existing and changed land-use practices or management. Data are obtained on rainfall and runoff on watersheds, and in some instances include sediment load measurements, ground-water levels, soil moisture storage and transmission, potential evapo-transpiration, vegetal covers, and soils as well as characteristics of runoff from agricultural and forested watersheds.

(g) During the 10-year period 1941-1950 the cover improvement and erosion control in the Pine Tree Branch watershed (formerly Henderson County project) have resulted in a decrease in surface runoff volumes and an increase in ground-water discharges, marked reductions in summer and winter peak flood discharges, a reduction in overland surface velocities, a prolongation of the period of draining of surface runoff from the channel system, and a 90 percent reduction in the sediment load. During the 21-year period 1935-1955, the forest cover improvement in the White Hollow watershed has resulted in greater watershed protection with measurable decrease in water yield, no change in volume of either surface runoff or ground-water runoff, marked reductions in summer peak rates of discharge with lesser reductions in winter rates, a prolongation of the period of draining of surface runoff from the channel system, and a 96 percent reduction in the sediment load.

(h) "Influences of Reforestation and Erosion Control upon the Hydrology of the Pine Tree Branch Watershed - 1941 to 1950", Technical Monograph No. 86, Knoxville, Tennessee, 1955. TVA, Treasurer's Office, Knoxville ($1.50). Report in preparation covering the forest cover improvement influences on hydrologic characteristics of White Hollow watershed (1935-1955).

(779) MAXIMUM POSSIBLE PRECIPITATION IN TESSESSEE VALLEY.

(b) Cooperative with U. S. Weather Bureau.

(d) Theoretical; applied research.

(e) Hydrometeorological analysis of large storms with upward adjustments of controlling factors to maximum limits as applied to the Tennessee Valley and subdivisions.

(g) Results to be published as one of current series of hydrometeorological reports by the U.S.W.B. and cooperating agencies.

(780) PERIODIC EVALUATION OF GROUND-WATER STORAGE.

(d) Theoretical; operation.

(e) By analysis of current records of stream discharge, the volumes of runoff in ground-water and channel storage are determined for use in operation of multi-purpose reservoirs.

(g) Results reported monthly and weekly within the organization.

(2248) RAIN GAGE LOCATION STUDIES--FLINT RIVER WATERSHED.

(d) Field investigation; applied research.

(e) A study, similar to that on the South Chickamauga Creek Watershed (1801), to determine the most advantageous location and necessary density of rain gages to obtain the desired accuracy in storm rainfall for river forecasting purposes, on a watershed having in general a gently rolling topography. In addition to one existing nonrecording rain gage and two existing recording rain gages in or adjacent to the area, eight nonrecording gages were established on the watershed, which has a drainage area of 342 square miles. These gages were located to provide approximately uniform distribution throughout the watershed.

(f) Daily observation beginning November 1, 1954 and ending April 30, 1956. Statistical analysis of data has been completed.

(h) Report completed for internal use.

(2480) FONTANA RESERVOIR BANK STORAGE.

(d) Experimental; applied research.

(e) Bank storage is indicated if during the annual operation of a storage reservoir more water enters into or is withdrawn from storage than is determined from the topographic storage curve. This bank storage is defined as the water that is stored in the bottom and sides of the reservoir. A study is being made to evaluate the amount of bank storage in Fontana Reservoir during the large annual fluctuations of 1953 and 1954. Reservoir storage volumes will be computed from inflows and outflows by using U. S. Geological Survey average daily flows and making proper allowance for rain falling directly on the reservoir surface, evaporation from the reservoir surface, leakage, and diversion. The difference between these computed storage volumes and those indicated by the topographic reservoir storage curve will represent the bank storage.

(f) Completed.

(g) Results indicate that discrepancies in observed data used for study obscure the effect of bank storage.

(h) Report in preparation for internal use.

(2975) SUPPLY AND UTILIZATION OF WATER IN THE TENNESSEE VALLEY.

(c) Mr. Reed A. Elliot, Chief Water Control Planning Engineer, Tennessee Valley Authority, Knoxville, Tennessee.

(d) Assembly and analysis of basic information on water resources and uses, including field investigation of water uses for irrigation, mining operations, industry, and other purposes.

(e) All available data will be analyzed to present a comparison of the water resource of the area with the present and expected 1975 demand upon that resource. Problems of shortage and conflict will be developed and possible solutions suggested.

UNIVERSITY OF BRITISH COLUMBIA, Hydraulics Lab.

(1044) FRASER RIVER MODEL.

(b) Hydraulic model studies cooperative with the Department of Public Works of Canada, Vancouver, B. C.

(c) Prof. E. S. Pretious, Dept. of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental project to aid engineering studies of navigation requirements involving river regulation and control.

(e) An outdoor erodible-bed tidal river model to study methods for improving and maintaining the navigation channels of the Fraser River estuary. Horizontal scale 1:600, vertical scale 1:70. The model occupies approximately 4 acres of the campus and represents the tide-water reaches of the lower Fraser River extending from its seaward end at the Strait of Georgia to the head of tide water at Sumas, a distance of approximately 60 miles. Pitt River and Pitt Lake (30 square miles in area) are subject to tidal influence and are included in the model. Natural tides and river discharges can be synchronized and simulated on the model and are controlled automatically by electronic servo-systems. Sand injection can be controlled automatically as a function of river discharge. Instantaneous water surface slopes can be obtained over the whole model by automatic electrically-recording point gauges situated at controlling points. Natural river sand of appropriate grain size is used for the bed material.

(h) Progress and technical reports submitted periodically to the Dept. of Public Works of Canada.

(2736) FRASER RIVER HYDRO AND FISHERIES RESEARCH PROJECT.

(b) Project financed by a grant from the Western Development and Power Corporation.

(c) Dr. G. M. Shrum, Chairman, Fraser River Hydro and Fisheries Research Project Committees.

(d) Engineering research on the design of fish-handling facilities at power dams.

(e) A study of existing facilities including fish ladders, fish locks of the pressure and gravity types, power-house collecting systems, auxiliary flow systems, spillways, turbine intakes, fingerling by-passes, aerial and inclined tramways, rotary-drum screen installations and hatcheries was made at the multipurpose projects on the Columbia River and elsewhere in Washington and Oregon. The purpose of the study was to find if suitable methods could be evolved for passing upstream and downstream migrant salmon at two proposed power dams on the Fraser River, one 700-feet high at Moran, and the other 100-feet high in the lower Fraser Canyon. The anadromous salmon of the Fraser River system include the spring, sockeye, coho, pink, chum and steelhead.

(h) "Fish Protection and Power Development on the Fraser River", prepared by E. S. Pretious, L. R. Kersey and G. P. Contractor. "Some Notes Following a Visit to the U. S. Pacific Northwest Concerning Recent Developments in Fish Facilities and Research", by E. S. Pretious and L. R. Kersey, in process of preparation.

(2737) CURVED CHANNEL FLOW.

(b) Laboratory project - financed by National Research Council grant.

(c) Dr. A. W. Marris, Dept. of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental; basic research.

(e) An experimental study of the mean radial velocity distribution for fully developed turbulent flow under pressure in a curved channel was undertaken to check the theoretical radial mean velocity distribution obtained by the author the previous year. The mean radius of the channel was 4 inches and its section was 2 x 12 inches. Flow rings were installed to cut down secondary flow. Radial velocity traverses were made at two stations at the equator of the channel utilizing small Pitot tubes made of stainless steel hyperdermic tubing, 0.058 inch O.D. Two types of Pitot tubes were used in order to investigate the flow in the convex and concave boundary layers. The Pitot tubes were traversed across the 2-inch channel width by micrometer traversing mechanics which positioned the Pitot tubes to 0.001 inch. The Pitot tubes were calibrated by traversing the flow in a long straight pipe along perpendicular diameters.

(g) Consistent results were obtained with the small Pitot tubes their coefficient being close to the standard value 0.865. Three flows were employed to date, mean velocities 5.622, 10.09, 12.58 ft/sec and it was found that the "reduced" distributions obtained by dividing the velocity at the point by the mean velocity coalesced to a single curve as required by the theory. The distribution is of the form predicted by the theory. It is intended to obtain distributions for a wider range of channel Reynolds number before submitting data for publication.

(h) "Steady State Heat Transfer to Fully Developed Turbulent Flow in a Curved Channel", by A. W. Marris, Can. J. Physics, 35, 410-434, 1957.
"On Fully Developed Turbulent Flow in Curved Channels", by A. W. Marris, Can. J. Physics, 34, 1134-1146, 1956.

(2976) DEAS ISLAND TUNNEL.

(b) Hydraulic model studies cooperative with the Foundation of Canada Engineering Corporation Limited, Montreal, Canada, and Christiani and Nielsen, Ltd., Copenhagen, Denmark.

(c) Prof. E. S. Pretious, Department of Civil

Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental project to study the effect of the Deas Island Tunnel on the local shoal and scour behavior of the bed of the lower Fraser River and to study the effect of the tunnel on flow patterns and velocities at the tunnel, near the banks, and at the Ladner Reach bifurcation immediately downstream.

(e) The Fraser River Model (already described) was used for these tests because the Deas Island Tunnel crosses under the lower estuary and joins Lulu Island on the north side to Deas Island on the south. The tests were necessitated by the fact that the tunnel projects above the river bed for a considerable portion of its length. The tunnel is a highway crossing being built by the B. C. Government and will accommodate 2 roadways each 27 feet wide. The tunnel elements are made of reinforced concrete and steel, each element being 344 feet long, 78 feet wide and 23 feet 6 inches high and weighing 18,000 tons. There are 6 elements in all.

(f) Completed.

(g) The studies indicated that the presence of the tunnel will have no major effect on the regime of the river. The discharges and flow pattern into Ladner Reach will remain essentially the same. Navigation will not be hampered and the depth clearances will be adequate. Some scour of the bed and south bank occurred during the imposition of the 1,000-year flood.

(h) Report submitted to the Foundation of Canada Engineering Corporation Limited and Christiani and Nielsen.

(2977) DEAS ISLAND TUNNEL.

(b) Hydraulic model studies cooperative with the Foundation of Canada Engineering Corporation Limited, Montreal, Canada and Christiani and Nielsen Ltd., Copenhagen, Denmark.

(c) Prof. E. S. Pretious, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental project to aid engineering designs for a stable and economical rock blanket to cover the Deas Island Tunnel.

(e) An undistorted 1:50 scale model representing a 100-foot length of the prototype tunnel and preliminary rock blanket designs was placed in a steel and glass flume in the University hydraulic laboratory. The erodible-bed material was natural Fraser River sand with a median diameter of 0.18 mm. The bed conformed to the deepest soundings on the tunnel center line and extreme conditions of discharge and water-surface elevations based on probability, were imposed on the model in the steady state. A wide range of discharges and water-surface elevations were used in the tests to cover the most adverse hydraulic conditions that might occur as a result of a combination of very high river flows and

very low tides. The model was non-tidal and was operated in accordance with the Froude Law for dynamical similarity.

(f) Completed.

(g) The studies indicated the best weight of rock to use for the tunnel blanket in order to ensure the safety of the tunnel and also indicated the most economical and efficient size of blanket.

(h) A report is in preparation which will be submitted to the Foundation of Canada Engineering Corporation Limited and Christiani and Nielsen.

(2978) KOOTENAY RIVER BRIDGE.

(b) Hydraulic model studies cooperative with the Foundation of Canada Engineering Corporation Limited, Montreal, Canada.

(c) Prof. E. S. Pretious, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental project to study the action of the river at the proposed bridge site which is part of the southern Provincial Highway between Creston and Salmo involving the crossing of the Kootenay River.

(e) The model was designed for a study of river action and the influence of proposed structures at the bridge site under selected conditions obtained by analysis of available records. The model had a horizontal scale of 1:160 and a vertical scale of 1:40 and the erodible bed was composed of sand having a median diameter of 0.18 mm. The steep banks were moulded in concrete and the model length represented a river reach extending 2,000 feet upstream and 2,000 feet downstream from the bridge center line. The model was constructed in a large concrete flume in the hydraulics laboratory and was operated in accordance with the Froude Law for dynamical similarity. Studies were made of bank erosion, effects of pier location on flow patterns and the maneuverability of log booms and rafts, effect of pier shape on bed scour and the effect of a shear boom on flow patterns and erosion.

(f) Completed.

(g) The test results answered all the questions relative to this study. Piers of various shapes on a larger undistorted scale (1:60) were tested separately in a steel and glass flume to determine more exact details of local bed scour.

(h) A report has been prepared by the Foundation of Canada Engineering Corporation Limited and submitted to the Minister of Highways for the Province of British Columbia.

(2979) HARRISON RIVER.

(b) Hydraulic model studies cooperative with the Department of Public Works of Canada, Vancouver, B. C.

(c) Prof. E. S. Pretious, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental project to aid engineering studies to provide low water navigation on the Harrison River at Harrison Mills, B.C. The inside of a fairly sharp bend has required intermittent dredging to provide a depth of 6 feet at local low water.

(e) A model study seemed feasible for obtaining some information for the placement of control structures to alleviate dredging maintenance, improve velocities and direction for tows approaching the shear boom at the C. P. R. bridge piers. The piers were originally constructed at a skew angle with the current making navigation difficult and hazardous. The model was constructed with an erodible bed in an outdoor testing basin measuring 40 feet long and 20 feet wide, adjacent to the Fraser River Model. The model had a horizontal scale of 1:186.5 and a vertical scale of 1:33.3.

(f) Completed.

(g) Several combinations of structures were tested. Structures similar to ones located in the Port Mann channel of the Fraser River seemed to provide the desired results.

(h) A report will be prepared by the Department of Public Works of Canada, Vancouver, B.C.

(2980) BRIDGE RIVER POWER PLANT NO. 1 TUNNEL INTAKE TOWER AND CYLINDER GATE.

(b) Hydraulic model studies cooperative with the B. C. Engineering Co. Ltd., Vancouver, B. C.

(c) Prof. E. S. Pretious, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Experimental project to check the action of hydraulic forces on the existing cylinder gate for various gate openings at maximum and minimum flows. The cylinder gate was designed for emergency closures in the event of a break in the penstock leading to the power house. The penstocks take the water from the tunnel which is over 2 miles long to the power house on the north shore of Seton Lake over 1,000 feet below the tunnel portal.

(e) The model of the tunnel intake tower and cylinder gate is made entirely of laminated and stretch-formed plexiglass to an undistorted scale of 1:36 or 1 inch = 3 feet. The complicated shape of the intake transitions made it necessary to construct plaster of paris core moulds on which to stretch-form the plexiglass intake walls. Attempts were made initially to cast the intake transitions from liquid polyester resins (monamers), to which a catalyst and a promoter had been added. The heat of polymerization in the thicker castings set up severe internal thermal stresses and subsequent cracking which could not be eliminated, consequently this method was abandoned in favor of laminating and stretch-forming. An attempt is being made to measure the dynamic forces of the flowing water on the cylinder gate by means of SR4 type A-7 strain gauges connected to two Universal amplifiers and a 2-channel brush oscillograph. To eliminate statical indeterminacy of forces only two pairs of compensating strain gauges are being used on cantilevered brass shim stock, one near the top and one near the bottom of the gate in the fore and aft position with respect to the flow. Considerable difficulty is being encountered in making the strain gauges waterproof since they are inside the intake tower. Provision is also made to measure the hydraulic down-pull forces on the cylinder gate.

(h) A report will be issued to the B. C. Engineering Co. Ltd.

(2981) SURGE TANK.

(b) Laboratory project financed by National Research Council grant.

(c) Dr. A. W. Marris, Department of Civil Engineering, University of British Columbia, Vancouver, Canada.

(d) Theoretical and experimental; basic research.

(e) Application of the mathematical methods of non-linear mechanics to the differential equation describing large oscillations of water level in a simple surge tank operating under the condition of constant hydraulic power acceptance by turbine. Employment of the hydraulic model previously constructed in which the constant power condition at the turbine was realized by a specially shaped plunger valve operated through levers by a slider with which the surge tank water level could be manually followed, for investigating: (1) The condition for stationary oscillations for the case of sudden acceptance of full load by turbine from an initial zero flow condition, and (2) the condition for drainage at low friction for the case of sudden acceptance of full load by turbine from an initial zero flow condition.

(f) Completed.

(g) It was found that in addition to the singularity at the point corresponding to the steady flow water level which accounts for small displacement phenomena, the equation possesses a second singularity which accounts for the phenomena of drainage at low friction, and indirectly for the fact that the classical Thoma condition gives instability. A condition for this type of drainage for case of instantaneous acceptance of full load by the turbine from an initial zero flow state was derived. Data from the model for low friction drainage was found to compare satisfactorily with the theoretical condition. Data from the model for the condition for stationary oscillation showed that the Thoma condition gave instability and the data obtained was more in agreement with the condition as derived on the basis of a limit cycle by G. Evangelisti: Sopre la Stabilita delle grandi oscillazioni nei pozzi piezometrici - L'energia elettrica, Vol. XXVIII, 1951, Milano, and with the condition given

by H. M. Paynter, Electrical Analogies and Electronic Computers, Trans. ASCE 962.

(h) "Large Water Level Displacements in Simple Surge Tank", by A. W. Marris, presently under review by American Society of Mechanical Engineers.
"Hydraulic Stability in the Simple Surge Tank", by A. W. Marris, Can. J. Technology, 34, 182-210, 1956.

LASALLE HYDRAULIC LABORATORY, Division of Neyrpic Canada Ltd.

Inquiries concerning Projects Nos. 2982 to 2991, inclusive, should be addressed to Mr. E. Pariset, LaSalle Hydraulic Laboratory, 0250 St. Patrick St., Ville LaSalle, P. Q., Canada.

(2982) EXPERIMENTAL STUDY ON TRANSPORT OF FLOATING BODIES IN OPEN CHANNELS.

(b) Laboratory project.
(d) Basic research both theoretically and experimentally.
(e) To find the basic laws governing the phenomenon of entrainment of floating bodies held against a surface cover in a flow. Calculations were made to determine the velocity of the flow for which a floating particle will start to be entrained under a retaining cover and experimental check was made with wooden blocks in a flume.
(f) The preliminary stage of the work is completed.
(g) It was possible to find the general law of entrainment and to determine the form factor experimentally for blocks of simple form.

(2983) MODEL TESTS TO DETERMINE THE LOCATION OF VICTORIA BRIDGE PIERS.

(b) Canadian National Railways.
(d) Model tests to help in the design of a bridge.
(e) A side-tracking of the railroad was to be built with a junction on the actual Victoria Bridge. To insure the least possible obstruction in the flow of the new piers, to prevent the formation of ice jams, tests were carried out to find their best location.
(f) Completed.
(g) The piers were located along the lines of current with very satisfactory results.

(2984) MODEL OF THE CHANNEL OF THE SEAWAY IN THE LACHINE RAPIDS SECTION.

(b) St. Lawrence Seaway Authority.
(d) Model studies to verify the effects of the construction of the Seaway.
(e) The model representing a section of the St. Lawrence River at the Lachine Rapids section was built at a scale of 1/125 vertically and 1/200 horizontally. The purpose of the model was to check the effect of the construction of the dyke, during its different construction phases and after completion on the water-level lines in the river and to obtain the field of velocities for these cases and specially near the entrance of the channel in Lake St. Louis.
(g) The model is in operation.

(2985) MODEL OF THE CHANNEL OF THE SEAWAY IN THE MONTREAL HARBOUR SECTION.

(b) St. Lawrence Seaway Authority.
(d) Model studies to verify the effects of the Seaway on the hydraulic conditions in the Montreal Harbour.
(e) This model represents the St. Lawrence River at the Montreal Harbour at a scale of 1/200 horizontally and 1/125 vertically. It was built to verify the effect of the construction of the dyke of the Seaway on the water level in the Harbour. One special point of the study was to determine the pattern of surface velocities before and after the construction of the entrance section of the Seaway in the Harbour.

(2986) MODEL OF THE DAM AT BACK RIVER.

(b) Quebec Hydro-electric Commission.
(d) The experimental tests were carried out to determine the most economical form of the structure.
(e) This dam will be equipped with gates and will serve a dual purpose. It will be used to limit the discharge of the River during periods of formation of ice jams at the power plant which is farther downstream the river and it will help to raise the level of the reservoir at other periods in order to divert more water in another outlet of this pond. The model of the structure was built at a scale of 1/50.
(f) Completed.
(g) To obtain the results desired, it was possible to reduce by more than half the number of gates used in the original design with a substantial economy in the project.

(2987) MODEL OF THE SPILLWAY OF THE LACHINE POWER PROJECT.

(b) Model built for the Quebec Hydroelectric Commission by Neyrpic Canada Ltd. and was operated with the full collaboration of "Ecole Polytechnique" of Montreal.
(d) The tests were carried out in order to ameliorate certain features of the design of the structure to be built in nature.
(e) The model represents three gate-ways of the spillway in a glass flume. Special study was to be made of the form of the piers to obtain a low contraction coefficient. The main purpose of the model was to check the extent of scouring at the downstream end and to find ways of protecting the structure against undermining.
(g) Main results up to date were the determination of an hydrodynamic form for the

upstream end of the piers which reduced the coefficient of contraction to 0.01.

(2988) MODEL OF THE CONTROL DAM AT THE MILLE-ILES RIVER.

(b) Quebec Hydro-electric Commission.
(d) These experimental tests were made to determine with precision the form of the structure.
(e) To prototype the dam will serve to regulate the level of the Lake of Two-Mountains, for which the Mille-Iles River is an outlet. The model reproduces a basin representing the lake and the control section of the river to a scale of 1/50. The purpose of the study was to design a structure that would give automatically a desired relation between the discharge of the dam and the level in the lake.
(f) Completed.
(g) An overflow weir was adopted with a central pass specially designed to maintain the natural discharges for the low levels of the lake.

(2989) GENERAL STUDY OF THE LACHINE POWER PROJECT.

(b) Quebec Hydro-electric Commission.
(d) Model tests to study the general hydraulic problems of the Lachine Power Project.
(e) The model built at a scale of 1/125 vertically and 1/200 horizontally is used to study the problems brought about by the construction of the project. Main problems are the determination of the river stages during the different phases of construction, and after completion of the project, the problem of the intake of the turbines and of the outlet of the draft tubes in the tailrace, and finally the problem of the formation of an ice cover in the forebay.

(2990) STUDY OF THE CONSTRUCTION OF THE COFFERDAM FOR THE LACHINE POWER PROJECT.

(b) Quebec Hydro-electric Commission.
(d) Model tests to design a cofferdam.
(e) Systematic tests are carried out to determine the characteristics of material to be used and the relative length of the cofferdam to be built by the method of dumping at the toe of the advancing dyke and the method of tipping the rockfill in horizontal layers from a bridge.

(2991) DESIGN OF AN ORIFICE-METER IN A SEWER.

(b) City of Montreal.
(d) Experimental.
(e) The meter is to be installed in a main sewer which flows in a river, with a permanent recording station in order to control the discharge for all conditions of flow. A model was made to calibrate the orifice for all conditions of tail water level and discharges and to make a special study of the forms to assure proper operation through very dirty water.
(f) Completed.

(g) An adequate design was found to solve the special problems encountered.

ÉCOLE POLYTECHNIQUE DE MONTREAL, Hydraulics Laboratory.

(266) HYDRAULIC MODEL STUDIES OF DIFFERENT SPILLWAY PROFILES.

(b) Laboratory project.
(c) Prof. Raymond Boucher, École Polytechnique, Montreal 18, Canada.
(d) Experimental; applied research.
(e) In order to establish a comparison between discharge capacities of different spillway designs, systematic testing has been undertaken on scale models of existing and recommended spillway profiles. Pressure distribution on spillway faces and coefficients of discharge are determined for various heads up to the design head. The effect of gate piers of various designs is also investigated.
(g) Studies have been conducted on eight different spillway models. It is proposed to test two more profiles before this investigation is completed.

(268) CALIBRATION TESTS OF A SHARP-CRESTED PARABOLIC WEIR.

(b) Laboratory project.
(c) Prof. Raymond Boucher, École Polytechnique, Montreal 18, Canada.
(d) Experimental; applied research.
(e) To obtain the head-discharge curve and head-coefficient of discharge curve for a sharp-crested parabolic weir designed for a maximum capacity of 3 cfs. The influence of viscosity is also investigated. This weir will be utilized to measure with precision the discharge into a glass-sided channel for scale model testing and open channel flow studies.
(f) This study has become active again in order to obtain additional data needed in the study of the influence of viscosity.

(2483) MODEL STUDY OF ENERGY DISSIPATOR FOR THE CITY OF MEGANTIC DEVELOPMENT ON THE CHAUDIERE RIVER, QUEBEC, CANADA.

(b) Côté, Lemieux, Carignan, Bourque, Consulting Engineers, Sherbrooke, Que., Canada.
(c) Prof. André Leclerc, École Polytechnique, 1430 St. Denis St., Montreal 18, Canada.
(d) Experimental; for design.
(e) The spillway channel consists of a concrete flume (bottom slope 8%) with the velocity at the lower end being 65 feet per second. The soil and foundation downstream is a very thick layer of varved clay. Tests were made on a 1:40 scale model in order to design a dissipation structure and protection for the earth channel which extends downstream from the concrete flume.
(f) Completed.

(g) A deeply submerged upturned bucket was adopted together with some rip-rap for a short distance downstream from the bucket.
(h) Report has been submitted to the sponsors.

(2992) MODEL TESTS OF SNOW-SLIDE OR AVALANCHE DEFLECTORS.

(b) The Aluminum Company of Canada Limited, Montreal, Canada.
(c) Mr. J. W. Forster, Aluminum Laboratories, 1800 Sun Life Bldg., Montreal, Que., Canada.
(d) Experimental; for design.
(e) To provide data for design of snow-slide or avalanche deflectors to protect towers and other structures along a mountain transmission line. Tests were conducted on scale-model deflectors in a glass-sided channel. Water flowing at high velocity was used to simulate snow slides and avalanches.
(f) Completed.
(g) Data on shape and dimensions of deflectors were incorporated in final designs of both splitter type deflectors to protect high structures and "overshot" deflectors to protect low structures.
(h) Report submitted to the sponsor.

(2993) HYDRAULIC MODEL STUDY OF A LOG CHUTE FOR THE MERCIER DAM, GATINEAU RIVER, QUE., CANADA.

(b) Department of Hydraulic Resources, Quebec, Canada.
(c) Prof. André Leclerc, École Polytechnique, 1430 St. Denis Street, Montreal 18, Canada.
(d) Experimental; for design.
(e) The logs floated on the Gatineau River vary in length from 4 to 16 ft or more. The width of the existing log chute is only 12 ft, and consequently it cannot be used efficiently for important logging operations. A 1:24 scale model has been built to investigate the most economical design of a new log chute. The model logs have been reproduced to the same scale. The roughness of the model downstream from the spillway has been adjusted to verify the slope of the water surface and the formation of jams experienced on the prototype.
(g) Two adjacent spillway-gate openings each having a width of 20 ft have been modified in order to obtain an efficient log chute. It has been found that a logway channel should be excavated in the river bed downstream from the spillway, therefore the two gate openings have been located where the excavation required will be minimum.

(2994) HYDRAULIC MODEL STUDIES OF THE SPILLWAY FOR THE LACHINE POWER PROJECT.

(b) Quebec Hydro-Electric Commission and Neyrpic Canada Limited.
(c) Mr. Bernard Michel, Hydraulic Engineer, 0250 St. Patrick Street, Ville LaSalle, Que., Canada.
(d) Experimental; for design.
(e) A 1:74.4 scale model of three spillway

gate openings has been built in a 30-in. glass-sided channel. These studies are being carried out in order to improve certain features of the design of the structure to be built in nature. The form of the pier noses has been carefully studied to obtain a low coefficient of contraction. The main purpose of these model tests was to check the extent of erosion of the river bed downstream from the spillway and to provide means of protecting the structure against undermining.
(g) The main result to date is the determination of a hydrodynamic profile for the pier noses which reduces the coefficient of contraction to 0.01.

NATIONAL RESEARCH COUNCIL, Division of Mechanical Engineering.

Inquiries concerning Projects Nos. 1806, 2041, 2485 2488, 2490, 2995 to 2998, inc., should be addressed to Dr. D. C. MacPhail, Director, Division of Mechanical Engineering, National Research Council, Montreal Road, Ottawa, Ontario, Canada.

(1806) ST. LAWRENCE RIVER MODEL - PRESCOTT-CARDINAL REACH.

(b) Department of Transport.
(d) Experimental project.
(e) A 1:240 by 1:48 scale model of the St. Lawrence River, representing about ten miles of river channel between the towns of Prescott and Cardinal, has been constructed and a comprehensive test program carried out. The model study was initiated to study the effect of engineering works in the form of navigational aids and channel changes in the Galop Rapids Reach, on the water level relationships throughout the reach.
(f) Testing program completed.
(g) Report in preparation.

(2041) ST. LAWRENCE RIVER MODEL - CORNWALL ISLAND REACH.

(b) St. Lawrence Seaway Authority.
(d) Experimental project; for design and development.
(e) A 1:480 by 1:96 scale model of five miles of the St. Lawrence River in the vicinity of the City of Cornwall has been constructed to study extensively both the navigation and power phases of the St. Lawrence Seaway and Power Project in the immediate area.
(g) The model is now being used to evaluate the construction procedures for the above project in its advanced stage.
(h) Interim reports have been submitted to the sponsor.

(2485) MODEL OF SOULANGES LOCK.

(b) St. Lawrence Seaway Authority.
(d) Experimental; for design.
(e) A 1:30 scale model of an 895 by 80-foot

navigation lock with a 45-foot lift has
been constructed. The filling and empty-
ing times and the hawser stresses on a
vessel during these operations are the
prime factors of interest. Three different
vessels, typical of those which will use
the St. Lawrence Seaway, have been used in
these tests.

(f) Testing program completed.
(g) Reports to sponsor in preparation.

(2488) MODEL OF PORT AUX BASQUES, NEWFOUNDLAND.

(b) Department of Public Works, Canada.
(d) Experimental project; for design.
(e) A 1:128 undistorted model of the harbor
has been constructed and operated satisfac-
torily with the aid of a wave machine and
wave profile recorders which were designed
and built in the laboratory.
(f) Test program completed.
(g) A scheme to reduce wave agitation within
the harbor by means of breakwaters and
other harbor improvements was effected. In
addition, a laboratory investigation of
the stability of the breakwater design has
been carried out and recommendations made
to the sponsor.
(h) Final report issued to sponsor.

(2490) FLOW OF FIBRE SUSPENSIONS.

(b) Laboratory project.
(d) Experimental study for basic research.
(e) Mechanics of flow of fibre suspensions,
particularly those used in the pulp and
paper industry are being studied in a
specially constructed pipeline. It is
hoped to evaluate the properties of the
suspension by means of velocity and pres-
sure measurements.
(g) Preliminary measurements have been made on
a suspension of synthetic fibres. This
has shown that for concentrations under 2%,
the suspension behaves as a Newtonian fluid.
More extensive study was made of a typical
sulphite pulp. This material was found to
have three regimes of flow. For low veloc-
ity there is a plug containing all the
fibre in the center of the pipe surrounded
by an annulus of water in laminar flow. As
the velocity increases the flow changes to
one of a plug surrounded by a turbulent
annulus and, finally, to fully turbulent
flow. In many cases friction factors of
the order one-half those for water have
been measured.
(h) "The Mechanics of Flow of a Dilute Fibre
Suspension", W. Douglas Baines. Proceed-
ings of Symposium on Flow of Suspensions,
National Research Council, pp. 39-54, Nov.
1956.

(2995) LOG CHUTE MODEL.

(b) Shawinigan Engineering Co. Ltd., Montreal,
Canada.
(d) Experimental for design and development.
(e) A 1/25 scale model of a log chute to be
used for transporting logs over a dam, as

part of a power development in Northern
Quebec, was constructed. Tests have been
conducted to evaluate the hydraulic char-
acteristics of the chute with emphasis on
the motion of masses of logs down the chute.
(f) Completed.
(g) Report issued to sponsor.

(2996) MODEL OF SPILLWAY AND APRON.

(b) Northern Canada Power Commission.
(d) Experimental for design and development.
(e) A 1/60 scale model of a spillway being
built as a part of a power project in the
Yukon, incorporating a short reach of the
river above and below the dam, was con-
structed. The model has been tested to
study the flow characteristics of the spill-
way and specifically to study the construc-
tion of the dividing walls and a flip buck-
et on the apron. All tests were performed
with a view to minimizing the scour down-
stream of the structure.
(f) Completed.
(g) Report being prepared for sponsor.

(2997) ST. MAURICE RIVER MODEL.

(b) Shawinigan Engineering Co. Ltd., Montreal,
Canada.
(d) Experimental project for design and devel-
opment.
(e) A 1:240 by 1:80 scale model of a 2 1/2-mile
reach of the St. Maurice River has been con-
structed. The purpose of this study is to
evaluate the extensive dredged channel
which is required to reduce the river slope
so that the tailwater at an adjacent power
plant can be materially reduced.

(2998) A STUDY TO DETERMINE THE CHARACTERISTICS
OF SIDE-DISCHARGE ORIFICES.

(b) Laboratory project.
(d) Experimental study for basic research.
(e) An experimental determination of the flow
characteristics of short, side-discharge
orifices is under way. A 6-inch square
pipe is used as the conduit and the ori-
fices are short, straight tubes 1-inch long
with diameter varying from 1/2 inch to 2
inches. The characteristics under study
are the contraction coefficient of the jet,
the change of the piezometric head between
the conduit and the outside and the jet de-
flection angle, which all vary with orifice
and conduit discharge.
(g) The results so far show that three differ-
ent types of flow are possible. The first
two are flow from a sharp-edged orifice
and a short tube which are identical to
the flow from an end orifice. The third
is a distinctive type in which there is
separation at the upstream edge of the hole
but not at the downstream edge.

ONTARIO AGRICULTURAL COLLEGE, Department of Engi-
neering Science.

(2492) RUNOFF FROM SMALL WATERSHEDS.

(b) Laboratory project.
(c) Prof. D. F. Witherspoon, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Experimental; applied research.
(e) Relationship of precipitation and snow melt to runoff characteristics on four watersheds of 20 acres each under various land use practices is being evaluated.
(g) Winter surface runoff from watersheds with good grass legume cover is greater than from watersheds ploughed the previous fall.

(2498) THE USE OF INFILTRATION DETERMINATIONS FOR RUNOFF ESTIMATES.

(b) Laboratory project.
(c) Prof. H. D. Ayers, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Experimental; basic research, development.
(e) The purpose of the project is to evaluate the separate factors affecting infiltration and to develop a technique for runoff estimation on a watershed utilizing infiltration data.
(f) Suspended.
(h) "The Effect of Crop Cover on the Infiltration Characteristics of Guelph Loam Soil", H. D. Ayers, Canadian Journal of Soil Science, Vol. 37:2, 128-133, 1957. "The Effect of the Water - Storage Capacity of the Soil on Mass Infiltration", H. D. Ayers and V. E. A. Wikramanayake, Canadian Journal of Soil Science (in press).

(2739) PERMEABILITY OF THE SOIL IN THE FROZEN STATE.

(b) Laboratory project.
(c) Prof. D. F. Witherspoon, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Experimental; basic research.
(e) Air permeabilities will be obtained of soils at various moisture content in the frozen state. The results will be used to determine if there is a correlation of moisture content and permeability of frozen soils on experimental watersheds.

(2740) MAIN TILE DRAIN SIZES FOR COMPOSITE DRAINAGE OF BROOKSTON CLAY SOIL.

(b) Laboratory project.
(c) Prof. F. R. Hore, Ontario Agricultural College, Guelph, Ontario, Canada.
(d) Field investigation; applied research.
(e) Discharge measurements from lateral tile drains in Brookston clay soil are being made to determine the proper drainage coefficient to use in the design of main tile drains and to determine the effect of lateral tile drain spacing on the drainage rate.

(2999) MECHANICAL DRAINAGE OF AGRICULTURAL LANDS.

(b) Laboratory project.
(c) Professors R. W. Irwin and F. R. Hore, Ontario Agricultural College, Guelph, Ont.

(d) Field investigations; design
(e) A survey was made of pump drainage installations to review their effectiveness, design criteria, costs and maintenance. This study is to be used as a guide for future designs of pump drainage installations.
(f) Completed.
(g) Of the 114 pumping plants assessed, it was found that there was no consistent design criteria being used throughout. The results indicated that the necessary pumping capacity in gallons per minute should be approximately equal to 200 times the acreage to the 0.61 power.

QUEEN'S UNIVERSITY, Hydraulics Laboratory.

(2044) ECONOMICAL CONSTRUCTION OF SAFE PULPWOOD HOLDING GROUNDS.

(b) Pulp and Paper Research Institute of Canada Limited, 3420 University Street, Montreal, Quebec, Canada.
(c) Prof. R. J. Kennedy, Dept. of Civil Engineering, Queen's University, Kingston, Ontario, Canada.
(d) Applied research; experimental field and laboratory investigation.
(e) Field and laboratory model investigation of forces acting on various types of pulpwood holding grounds.

UNIVERSITY OF TORONTO, Dept. of Mechanical Engrg.

(1298) DISCHARGE CHARACTERISTICS OF WEIR TYPE SPILLWAYS.

(b) Laboratory project.
(c) Prof. L. E. Jones, University of Toronto, Toronto 5, Canada.
(d) Experimental; applied research for Master's theses.
(e) A long term research carried out with a view to systematizing discharge characteristics for spillways having various pier spacings and proportions.

(3000) STABILITY OF CANAL LININGS.

(b) Laboratory project.
(c) Prof. G. Ross Lord, University of Toronto, Toronto 5, Canada.
(d) Experimental; applied research for Master's thesis.
(e) An investigation to correlate size of rock lining with dynamic stability.

(3001) RELATIONSHIP BETWEEN EXTREME PRECIPITATION AND FLOOD FLOW IN THE TORONTO AREA.

(b) Laboratory project.
(c) Prof. D. G. Huber, University of Toronto, Toronto 5, Canada.
(d) Office investigation; applied research for Master's thesis.

(e) A study to correlate field data observed
     during Hurricane Hazel.

(3002) PERFORMANCE CHARACTERISTICS OF PLUNGER-
        TYPE WAVE GENERATORS.

(b) Laboratory project.
(c) Prof. L. E. Jones, University of Toronto,
     Toronto 5, Canada.
(d) Experimental; applied research for Master's
     theses.
(e) Studies to relate shape, frequency, stroke
     and mean penetration of plunger with the
     characteristics of the generated waves.

(3003) ROUGHNESS PHENOMENA IN OPEN CHANNEL FLOW.

(b) Laboratory project.
(c) Prof. L. E. Jones, University of Toronto,
     Toronto 5, Canada.
(d) Experimental; basic research for Doctoral
     thesis.
(e) An investigation into the mechanism of open
     channel roughness, with ultimate reference

to distorted scale models.

(3004) FLOW CONFIGURATION IN A NUCLEAR REACTOR
        CORE ASSEMBLY.

(b) Laboratory project.
(c) Prof. L. E. Jones, University of Toronto,
     Toronto 5, Canada.
(d) Experimental; applied research for Master's
     thesis.
(e) A study of fuel rod size and spacing in re-
     lation to coolant flow configuration.

(3005) GRADING OF PARTICLE SUSPENSIONS BY CENTRIF-
        UGAL METHODS.

(b) Laboratory project.
(c) Prof. L. E. Jones, University of Toronto,
     Toronto 5, Canada.
(d) Experimental; applied research for Master's
     thesis.
(e) A study of the dynamics of centrifugal
     separation of fine particles from a liquid
     carrier.

THE NATIONAL BUREAU OF STANDARDS

The scope of activities of the National Bureau of Standards at its headquarters in Washington, D. C., and its major laboratories in Boulder, Colo., is suggested in the following listing of the divisions and sections engaged in technical work. In general, each section carries out specialized research, development, and engineering in the field indicated by its title. A brief description of the activities, and of the resultant publications, appears on the inside front cover.

WASHINGTON, D. C.

Electricity and Electronics. Resistance and Reactance. Electron Devices. Electrical Instruments. Magnetic Measurements. Dielectrics. Engineering Electronics. Electronic Instrumentation. Electrochemistry.

Optics and Metrology. Photometry and Colorimetry. Optical Instruments. Photographic Technology. Length. Engineering Metrology.

Heat. Temperature. Physics. Thermodynamics. Cryogenic Physics. Rheology. Engine Fuels. Free Radicals Research.

Atomic and Radiation Physics. Spectroscopy. Radiometry. Mass Spectrometry. Solid State Physics. Electron Physics. Atomic Physics. Neutron Physics. Nuclear Physics. Radioactivity. X-rays. Betatron. Nucleonic Instrumentation. Radiological Equipment.

Chemistry. Organic Coatings. Surface Chemistry. Organic Chemistry. Analytical Chemistry. Inorganic Chemistry. Electrodeposition. Molecular Structure and Properties of Gases. Physical Chemistry. Thermochemistry. Spectrochemistry. Pure Substances.

Mechanics. Sound. Mechanical Instruments. Fluid Mechanics. Engineering Mechanics. Mass and Scale. Capacity, Density, and Fluid Meters. Combustion Controls.

Organic and Fibrous Materials. Rubber. Textiles. Paper. Leather. Testing and Specifications. Polymer Structure. Plastics. Dental Research.

Metallurgy. Thermal Metallurgy. Chemical Metallurgy. Mechanical Metallurgy. Corrosion. Metal Physics.

Mineral Products. Engineering Ceramics. Glass. Refractories. Enameled Metals. Concreting Materials. Constitution and Microstructure.

Building Technology. Structural Engineering. Fire Protection. Air Conditioning, Heating, and Refrigeration. Floor, Roof, and Wall Coverings. Codes and Safety Standards. Heat Transfer.

Applied Mathematics. Numerical Analysis. Computation. Statistical Engineering. Mathematical Physics.

Data Processing Systems. SEAC Engineering Group. Components and Techniques. Digital Circuitry. Digital Systems. Analog Systems. Application Engineering.

• Office of Basic Instrumentation.   • Office of Weights and Measures.

BOULDER, COLORADO

Cryogenic Engineering. Cryogenic Equipment. Cryogenic Processes. Properties of Materials. Gas Liquefaction.

Radio Propagation Physics. Upper Atmosphere Research. Ionospheric Research. Regular Propagation Services. Sun-Earth Relationships. VHF Research.

Radio Propagation Engineering. Data Reduction Instrumentation. Modulation Systems. Navigation Systems. Radio Noise. Tropospheric Measurements. Tropospheric Analysis. Radio Systems Application Engineering. Radio Meteorology.

Radio Standards. High Frequency Electrical Standards. Radio Broadcast Service. High Frequency Impedance Standards. Electronic Calibration Center. Microwave Physics. Microwave Circuit Standards.